

CODE FOR LIFTING APPLIANCES IN A MARINE ENVIRONMENT

JULY 2008

A guide to the Rules

Code for Lifting Appliances in a Marine Environment

Introduction

These Rules are published as a complete book.

Numbering and Cross-References

A decimal notation system has been adopted throughout. Five sets of digits cover the divisions, i.e. Section, sub-Section and paragraph. The textual cross-referencing within the text is as follows, although the right hand digits may be added or omitted depending on the degree of precision required:

- (a) In same Section, e.g. see 2.1.3 (i.e. down to paragraph).
- (b) In another book, e.g. see Pt 2, Ch 1,3 of the *(name of book)* (i.e. down to Section).

The cross-referencing for Figures and Tables is as follows:

- (a) In same Section, e.g. as shown in Fig. 3.5 (i.e. Section and Figure Number).
- (b) In another book, e.g. see Table 2.7.1 in Pt 3, Ch 2 of the *(name of book)*.

Rules updating

These Rules are published and changed through a system of Notices. Subscribers are forwarded copies of such Notices when the Rules change.

Current changes to the Rules that appeared in Notices are shown with a black rule alongside the amended paragraph on the left hand side. A solid black rule indicates amendments and a dotted black rule indicates corrigenda. A dot-dash line indicates changes necessitated by International Conventions, Code of Practice or IACS Unified Requirements.

July 2008

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General Regulations

Sections 1 & 2

■ Section 1

1.1 Lloyd's Register (hereinafter referred to as 'LR'), which is recognized under the laws of the United Kingdom as a corporate body and a charity established for the benefit of the community, was founded in 1760. It was established for the purpose of producing a faithful and accurate Classification of Merchant Shipping. It now primarily produces Classification Rules.

1.2 Classification services are delivered to clients by a number of other members of the Lloyd's Register Group, including: Lloyd's Register EMEA, Lloyd's Register Asia, Lloyd's Register North America, Inc., and Lloyd's Register Central and South America Limited.

1.3 The Lloyd's Register Group (hereinafter referred to as 'the LR Group') comprises charities, other forms of organisation and non-charitable companies, with the latter supporting the charities in their main goal of enhancing the safety of life and property, at sea, on land and in the air, for the benefit of the public and the environment.

■ Section 2

2.1 LR remains the sole classification society in the LR Group. LR is managed by a corporate trustee Lloyd's Register Trustees Limited (hereinafter referred to as 'LR's trustee').

LR's trustee has:

Appointed a Classification Committee and determined its powers and functions;
Appointed Technical Committees and determined their powers, functions and duties.

2.2 The LR Group has established National and Area Committees in the following:

Countries:

Australia (via Lloyd's Register Asia)
Canada (via Lloyd's Register North America, Inc.)
China (via Lloyd's Register Asia)
Egypt (via Lloyd's Register EMEA)
Federal Republic of Germany
(via Lloyd's Register EMEA)
France (via Lloyd's Register EMEA)
Italy (via Lloyd's Register EMEA)
Japan (via Lloyd's Register Asia)
New Zealand (via Lloyd's Register Asia)
Poland (via Lloyd's Register (Polska) Sp zoo)
Spain (via Lloyd's Register EMEA)
United States of America (via Lloyd's Register North America, Inc.)

Areas:

Benelux (via Lloyd's Register EMEA)
Central America (via Lloyd's Register Central and South America Ltd)
Nordic Countries (via Lloyd's Register EMEA)
South Asia (via Lloyd's Register Asia)
Asian Shipowners (via Lloyd's Register Asia)
Greece (via Lloyd's Register EMEA)

General Regulations

Section 3

3.1 LR's Technical Committee is at present composed of:

Ex officio members:

• The Chairman of Lloyd's Register Holdings (LRH)	1
• The Chairman of the Classification Committee	1

Members Nominated by:

• The General Committee of Trustees of LRH	18
• The Royal Institution of Naval Architects	2
• The Institution of Engineers and Shipbuilders in Scotland	2
• The Institute of Marine Engineers	2
• The Institution of Mechanical Engineers	2
• The Shipbuilders' and Shiprepairers' Association	2
• The Short Sea Group of the Chamber of Shipping	1
• The Society of Consulting Marine Engineers and Ship Surveyors	1
• The Institute of Materials	1
• The UK Steel Association	1
• The Honourable Company of Master Mariners	2
• The Institution of Electrical Engineers	1
• Federation of British Electrotechnical and Allied Manufacturers' Associations	1
• The Technical Committee	18
• The Technical Committee (from other countries)	18
• The Institute of Refrigeration	1
• International Oil Companies	2
• Association of European Shipbuilders and Shiprepairers	1
• Greek Shipping Co-operation Committee	1

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3.2 In addition to the foregoing:

- (a) Each National or Area Committee may appoint a representative to attend meetings of the Technical Committee.
- (b) A maximum of five representatives from National Administrations may, with the consent of the Technical Committee, be co-opted to serve on the Technical Committee. Such representatives may also be elected as members of the Technical Committee under one of the categories identified in 3.1.
- (c) Further persons may, with the consent of the Technical Committee, be co-opted to serve on the Technical Committee.

3.3 All elections are subject to confirmation by LR's trustee.

3.4 The function of the Technical Committee is to consider any technical problems connected with LR's business and with the exception of changes necessitated by mandatory implementation of International Conventions, Codes or Unified Requirements adopted by the International Association of Classification Societies, any proposed alterations in the existing Rules and to frame new Rules for classification as deemed necessary.

3.5 The term of office of the Chairman and of all members of the Technical Committee is five years. Members may serve one additional term of office with the approval of LR's trustee. The term of the Chairman may be extended with the approval of LR's trustee.

3.6 In the case of continuous non-attendance of a member, the Technical Committee may withdraw his/her membership.

3.7 Meetings of the Technical Committee are convened as often and at such times and places as is necessary, but there is to be at least one meeting in each year.

3.8 Any proposal of the Technical Committee involving any alteration in, or addition to, Rules for Classification is referred to LR's Trustee which has agreed to seek the comments of the Lloyd's Register Holding's General Committee of Trustees before adopting the proposal.

3.9 The Technical Committee is empowered to:

- (a) appoint sub-Committees or panels; and
- (b) co-opt to the Technical Committee, or to its sub-Committees or panels, representatives of any organization or industry or private individuals for the purpose of considering any particular problem.

General Regulations

Sections 4 & 5

■ Section 4

4.1 LR's Naval Ship Technical Committee (hereinafter referred to as 'the NSTC') is at present composed of up to 50 members and includes nominees of:

- The Royal Navy and the UK Ministry of Defence;
- The Defence Evaluation and Research Agency;
- UK Shipbuilders, Ship Repairers and Defence Industry;
- Overseas Governments and Governmental Agencies;
- Overseas Shipbuilders, Ship Repairers and Defence Industries;
- Various maritime bodies and institutions, nominated by the NSTC;
- The Chairman of LRH and Chairman of the Classification Committee who are *ex officio* members.

4.2 All elections are subject to confirmation by LR's trustee.

4.3 All members of the NSTC are to hold security clearance from their National Authority for the equivalent of NATO CONFIDENTIAL. All material is to be handled in accordance with NATO Regulations or, for non-NATO countries, an approved equivalent. No classified material shall be disclosed to any third party without the consent of the originator.

4.4 The term of office of the NSTC Chairman and of all members of the NSTC is five years. Members may serve one additional term of office with the approval of LR's trustee. The term of the Chairman may be extended with the approval of LR's trustee.

4.5 In the case of continuous non-attendance of a member, the NSTC may withdraw that person's membership.

4.6 The function of the NSTC is to consider technical issues connected with Naval Ship matters and to approve proposals for new Naval Ship Rules, or amendments to existing Naval Ship Rules.

4.7 Meetings of the NSTC are convened as necessary but there will be at least one meeting per year.

4.8 Following approval by the NSTC, details of new Rules (or amendments) will be submitted to LR's trustee which will seek comments from LRH's General Committee of Trustees before adopting any changes.

■ Section 5

5.1 LR has the power to adopt, and publish as deemed necessary, Rules relating to Classification and has (in relation thereto) provided the following:

- (a) Except in the case of a special directive by LR's trustee, no new Regulation or alteration to any existing Regulation relating to classification or to class notations is to be applied to existing ships.
- (b) Except in the case of a special directive by LR's trustee, or where changes necessitated by mandatory implementation of International Conventions, Codes or Unified Requirements adopted by the International Association of Classification Societies are concerned, no new Rule or alteration in any existing Rule is to be applied compulsorily after the date on which the contract between the ship builder and shipowner for construction of the ship has been signed, nor within six months of its adoption. The date of 'contract for construction' of a ship is the date on which the contract to build the ship is signed between the prospective shipowner and the ship builder. This date and the construction number (i.e. hull numbers) of all the vessels included in the contract are to be declared by the party applying for the assignment of class to a newbuilding. The date of 'contract for construction' of a series of sister ships, including specified optional ships for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective shipowner and the ship builder. In this section a 'series of sister ships' is a series of ships built to the same approved plans for classification purposes, under a single contract for construction. The optional ships will be considered part of the same series of sister ships if the option is exercised not later than 1 year after the contract to build the series was signed. If a contract for construction is later amended to include additional ships or additional options, the date of 'contract for construction' for such ships is the date on which the amendment to the contract is signed between the prospective shipowner and the ship builder. The amendment to the contract is to be considered as a 'new contract'. If a contract for construction is amended to change the ship type, the date of 'contract for construction' of this modified vessel, or vessels, is the date on which the revised contract or new contract is signed between the Owner, or Owners, and the shipbuilder. Where it is desired to use existing approved ship or machinery plans for a new contract, written application is to be made to LR. Sister ships may have minor design alterations provided that such alterations do not affect matters related to classification.
- (c) That it will, in all cases, consult with LRH's General Committee of Trustees before passing any Rule amendment.
- (d) All reports of survey are to be made by Surveyors authorised by members of the LR Group to survey and report (hereinafter referred to as 'the Surveyors') according to the form prescribed, and submitted for the consideration of the Classification Committee.

General Regulations

Sections 5 to 8

- (e) Information contained in the reports of classification and statutory surveys will be made available to the relevant owner, National Administration, Port State Administration, P&I Club, hull underwriter and, if authorized in writing by that owner, to any other person or organization.
- (f) Information relating to the status of classification and statutory surveys and suspensions/withdrawals of class together with any associated conditions of class will be made available as required by applicable legislation or court order.
- (g) A Classification Executive consisting of senior members of LR's Classification Department staff shall carry out whatever duties that may be within the function of the Classification Committee that the Classification Committee assigns to it.

■ *Section 6*

6.1 No LR Group employee is permitted under any circumstances, to accept, directly or indirectly, from any person, firm or company, with whom the work of the employee brings the employee into contact, any present, bonus, entertainment or honorarium of any sort whatsoever which is of more than nominal value or which might be construed to exceed customary courtesy extended in accordance with accepted ethical business standards.

■ *Section 7*

7.1 LR has power to withhold or, if already granted, to suspend or withdraw any class (or to withhold any certificate or report in any other case), in the event of non-payment of any fee to any member of the LR Group.

■ *Section 8*

8.1 When providing services LR does not assess compliance with any standard other than the applicable LR Rules, international conventions, and other standards agreed in writing.

8.2 In providing services, information or advice, the LR Group does not warrant the accuracy of any information or advice supplied. Except as set out herein, LR will not be liable for any loss, damage or expense sustained by any person and caused by any act, omission, error, negligence or strict liability of any of the LR Group or caused by any inaccuracy in any information or advice given in any way by or on behalf of the LR Group even if held to amount to a breach of warranty. Nevertheless, if the Client uses LR's services or relies on any information or advice given by or on behalf of the LR Group and as a result suffers loss, damage or expense that is proved to have been caused by any negligent act, omission or error of the LR Group or any negligent inaccuracy in information or advice given by or on behalf of the LR Group, then a member of the LR Group will pay compensation to the client for its proved loss up to but not exceeding the amount of the fee (if any) charged for that particular service, information or advice.

8.3 Notwithstanding the previous clause, the LR Group will not be liable for any loss of profit, loss of contract, loss of use or any indirect or consequential loss, damage or expense sustained by any person caused by any act, omission or error or caused by any inaccuracy in any information or advice given in any way by or on behalf of the LR Group even if held to amount to a breach of warranty.

8.4 Any dispute about LR's services is subject to the exclusive jurisdiction of the English courts and will be governed by English law.

General

Chapter 1

Section 1

Section

- 1 **Introduction**
- 2 **Definitions**
- 3 **Plans and information to be submitted**

■ Section 1 Introduction

1.1 Application

1.1.1 It is a requirement of most National Authorities that lifting appliances are approved, examined, tested and certified by a competent person or organization before being taken into use and thereafter are periodically surveyed to maintain the validity of the certification.

1.1.2 Lloyd's Register's (hereinafter referred to as LR) certification is internationally accepted and, where requested, LR will undertake the necessary certification of lifting appliances and subsequent surveys to ensure compliance with the statutory Regulations.

1.1.3 In certain cases a National Authority requires its own certification to be used. Where authorized, LR is also able to arrange the issue of these certificates which may be in addition to LR certification if so desired by the Owner.

1.1.4 Ships or offshore units fitted with appliances built in accordance with this Code in respect of structural and machinery requirements will be eligible for Special Features class notations. These notations will be retained so long as the appliances are found upon examination at the prescribed surveys to be maintained in accordance with LR's requirements, see 1.3.

1.1.5 This Code is applicable to marine lifting appliances including:

- derrick and derrick crane systems;
- cranes;
- launch and recovery systems for diving operations;
- lifts and ramps;

where these are installed on ships or offshore units for the following purposes:

- (a) on ships, for handling cargo and equipment;
- (b) on barges and pontoons, e.g. a floating crane;
- (c) on fixed or mobile offshore installations, for transferring equipment;
- (d) on ships or fixed or mobile offshore installations, for handling manned submersibles and diving systems;
- (e) on ships, for transferring goods or personnel from one deck level to another.

1.1.6 Lifting appliances and applications not defined above will be considered on the general basis of the Code.

1.1.7 The Code is also applicable to mechanical docking systems mounted on quayside structures for lifting ships out of harbour waters by means of mechanically operated elevator platforms.

1.1.8 The Code embodies both the general requirements for compliance with major statutory Regulations for such applications, and the detailed requirements of LR either as an authorized body issuing statutory certificates or as an independent authority issuing its own form of certification.

1.1.9 It is emphasised that the Code deals primarily with the structural aspects of the lifting appliance. Driving mechanisms and similar mechanical parts are the responsibility of the designers of the gear but tests to demonstrate 'fail safe' operation will be required during commissioning trials. See Chapter 7.

1.1.10 It is also emphasised, that any item such as a mast or crane pedestal, which is permanently fitted to a ship's structure and which is designed to support a lifting appliance, does constitute part of the classed ship and is to comply with the appropriate classification requirements, even where the lifting appliance itself is not classed or certified by LR.

1.2 Certification

1.2.1 The certification adopted by LR is the recognized form recommended by the International Labour Office (I.L.O.) and is also in accordance with current relevant directives of the European Community (EC).

1.2.2 It is the responsibility of the Owner or Operator to ensure that they comply with statutory requirements. Particular attention is drawn to the specific requirements of some authorities who do not accept surveys carried out by ship's officers but require all surveys and certification to be carried out by nominated organisations such as LR.

1.2.3 Attention is also drawn to the more stringent requirements of certain authorities with respect to cranes offshore and lifting arrangements for diving operations.

1.2.4 It is LR's interpretation of the intention of current National Regulations that every lifting appliance, including oil hose derricks, stores cranes and engine room cranes, is to be certified and compliance with this is strongly recommended to the Owner.

1.2.5 The minimum requirements for the issue by LR of certification in accordance with the Code are:

- (a) Plan approval of the structural arrangements.
- (b) Verification of materials.
- (c) Verification of manufacturer's certificates for loose gear, ropes, etc.
- (d) Survey of the appliance.
- (e) Testing of the appliance when installed on board.

1.2.6 The above procedure is also to be applied so far as practicable in the case of existing appliances where LR's certification is required.

General**Chapter 1**

Section 1

1.2.7 Any request for LR's services is to make it quite clear if compliance with any specific Regulations is required. This is necessary for initial, periodical and any specific type of survey requested.

1.2.8 National and International Regulations require lifting appliances to receive Periodical Surveys and testing to maintain the validity of the certification.

1.2.9 Provided that the certification is valid, up to date and was issued by a competent authority, LR will, upon request, carry out the necessary survey requirements, issue appropriate certificates and endorse the register of lifting appliances carried by the ship.

1.2.10 The requirements for Periodical Surveys are given in Chapter 9.

1.3 Classification

1.3.1 Ships and offshore installations built in accordance with LR's Rules with respect to hull and machinery are eligible to be assigned a class in the *Register Book* and continue to be classed as long as it is found upon examination at the prescribed surveys that they are maintained in accordance with the Rules.

1.3.2 Ships or offshore units classed with LR and fitted with lifting appliances built in accordance with the requirement of this Code will be eligible to be assigned Special Features class notations in the *Register Book* as listed in Table 1.1.1.

1.3.3 Where the lifting appliance is considered to form an essential feature of a classed ship the Special Feature class notation **LA** will, in general, be mandatory.

1.3.4 In other cases classification is optional and may be assigned at the request of the Owner on compliance with the appropriate requirements, see also Chapter 4.

1.3.5 Proposals to class lifting appliances on unclassed ships or offshore units will be specially considered.

1.3.6 The minimum requirements for classification of a lifting appliance are:

- (a) Plan approval of the structural and mechanical arrangements in accordance with LR's requirements.
- (b) Verification of materials.
- (c) Verification of manufacturer's certificates and testing of loose gear, ropes and fittings.
- (d) Survey of the lifting appliance.
- (e) Testing of the lifting appliance on installation.
- (f) Subsequent Periodical Surveys of the lifting appliance as required by Chapter 9.

1.3.7 Classification also fully meets the relevant requirements for statutory certification of the lifting appliance.

1.3.8 It should be noted that certain movable support structures for loading and discharge arrangements such as the rotating support boom for a dredger discharge pipe, are considered an essential feature of the ship and are included in the classification of the ship. A separate notation is not assigned.

1.4 Equivalents

1.4.1 Recognized international or national standards for the design of installations will be accepted as equivalent to the Code requirements provided LR is satisfied in each case that the standard adequately takes into account all the forces resulting from the intended mode of operation. The relevant standard is to be specified in the submission.

1.4.2 Recognized international or national standards for components or fittings will, generally, be accepted as equivalent to the requirements of this Code.

1.4.3 Alternative arrangements or fittings which are considered to be equivalent to the requirements of this Code will be accepted.

Table 1.1.1 Special features class notations associated with lifting appliances

Lifting appliance	Special features class notations	Remarks
Derricks, derrick crane or cranes on ships	CG	Optional notation Indicates that the ship's cargo gear is included in class
Cranes on offshore installations	PC	Optional notation Indicates that the installation's platform cranes are included in class
Lifts and ramps on ships	CL PL CR	Optional notations Indicate that the ship's cargo lifts (CL), passenger lifts (PL) or cargo ramps (CR) are included in class
Lifting appliances forming an essential feature of the vessel, e.g. cranes on crane barges or pontoons, lifting arrangements for diving on diving support ships, etc.	LA	Mandatory notation Indicates that the lifting appliance is included in class

General

Chapter 1

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1.5 Calculations

1.5.1 Designers may be required to submit calculations for consideration when scantling plans are submitted for approval.

1.5.2 Where computer analysis forms the basis of the designer's determination of scantlings, details of the programs are to be specified together with the basic design criteria to assist in LR's approval procedures.

1.5.3 LR's direct calculation procedures within the *Lloyd's Register's Plan Appraisal Systems for Ships* (LR.PASS) facilities may be used to assist in the design process. The available procedures and facilities are presented in the report summarising LR.PASS.

1.5.4 Where approval is required for appliances of novel design or with features not covered by this Code, LR may require additional calculations to be carried out. In such cases LR is willing to undertake calculations for the designers.

■ Section 2

Definitions

2.1 Safe Working Load (SWL) of a lifting appliance

2.1.1 This is the maximum static load which the appliance is certified to lift whilst correctly rigged and operating simultaneously:

- (a) In the appropriate Service Category.
- (b) Within the designed Geometrical Limit.

2.1.2 The SWL of a lifting appliance is sometimes referred to as the working load limit.

2.2 Safe Working Load (SWL) of a lifting component (loose gear)

2.2.1 This is the certified load for which the component has been designed and tested. This certified load is to be not less than the maximum load to which the component will be subjected when the appliance of which it forms part is operating at its SWL.

2.3 Service category

2.3.1 **Standard service category.** This is the least onerous operational category which can be adopted for the purpose of ascertaining the safe working load (SWL) of any appliance. It is to embrace all of the following conditions:

- (a) The ship on which the appliance is installed adopting a heel of 5° in addition to a trim of 2°, each in a direction such as to affect adversely the lifting capacity of the appliance. In certain instances angles of heel and trim less than 5° and 2° respectively will be accepted provided the designers can show that in normal service it will not be possible for the vessel to exceed these values.

- (b) The appliance being operated whilst situated on a ship which is within the confines of a harbour.
- (c) The appliance being operated in wind speeds not exceeding 20 m/s, corresponding to a wind pressure not exceeding 250 N/m².
- (d) The load being free of any external constraints to its motion whilst it is being acted upon by the lifting appliance.
- (e) The nature of the lifting operations in terms of their frequency and dynamic character, being compatible with the *Factored Loads* permitted by the Code for the type of appliance concerned.

2.3.2 **Specified service category.** This is an operational category which is specified by the designer or operator for the purpose of designing the appliance for the safe working load (SWL). It is more onerous than the *Standard Service Category* by virtue of any of the following operational and environmental conditions being applicable:

- (a) The angles of heel and/or trim of the ship on which the appliance is situated being greater than those specified for the *Standard Service Category*.
- (b) The appliance being operated whilst situated on a ship which is not sheltered from the action of sea waves.
- (c) The appliance being operated in wind speeds exceeding 20 m/s, corresponding to a wind pressure exceeding 250 N/m².
- (d) The load not being at rest at the time when the appliance commences the lift.
- (e) The load not being free of external constraints to its motion whilst being acted upon by the lifting appliance.
- (f) The nature of the lifting operations, in terms of their frequency and dynamic character, being compatible with *Factored Loads* permitted by this Code for the type of appliance concerned.

2.4 Geometrical limit

2.4.1 This is any designed geometrical configuration of the lifting appliance in which a maximum stress which is not greater than the permissible stress, occurs in one or more of the component parts of the appliance when the latter is lifting its safe working load (SWL). It is possible for an appliance to be certified for a range of safe working loads in association with a corresponding range of *Geometrical Limits*.

2.5 Factored load

2.5.1 This is the load (excluding any wind increment) which is considered to act on a lifting appliance for the purpose of designing its component parts. It comprises the *Live Load* multiplied by factors which allow for the frequency with which the appliance is used (as represented by the *Duty Factor*) and the effects of accelerations of the system which have not been specifically determined and separately allowed for (as represented by the *Dynamic Factor*).

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Sections 2 & 3

2.6 Duty factor

2.6.1 This is a design factor which makes allowances for the frequency with which a lifting appliance is used. The *Duty Factor* is the factor by which the sum of all the static and dynamic loads acting on the system (excluding wind loading) must be multiplied to give the *Factored Load*.

2.7 Dynamic factor

2.7.1 This is a factor by which the *Live Load* is multiplied to represent the load on the system due to all dynamic effects which have not been explicitly determined and separately allowed for.

2.8 Live load

2.8.1 This is the sum of the Safe Working Load (SWL) of an Appliance and the static weight of any component of the appliance which is directly connected to, and undergoes the same motion as, the safe working load during the lifting operation.

2.9 Dead load

2.9.1 This is the self-weight of any component of the lifting appliance which is not included in the *Live Load*.

2.10 Design stress

2.10.1 This is the maximum stress permitted by the Code to which any component part of a lifting appliance may be subjected when the appliance is lifting its Safe Working Load (SWL), that is, when the appliance is subjected to the appropriate factors plus specified lateral and wind loads.

- (f) A list of blocks, chains, shackles, hooks, etc., indicating material, safe working load (SWL), proof load (PL) and the standard to which they have been manufactured.
- (g) A list of steel wire and fibre ropes giving size, construction, finish and certified breaking loads.
- (h) The material specification for steels to be used in the masts, derrick booms and associated fittings.

3.2 Crane systems

3.2.1 The following plans and calculations are to be submitted for approval:

- (a) Calculations clearly indicating the basis of design, operating criteria, rated capacities, weights and centres of gravity of the crane parts, and relevant national standards.
- (b) Scantling plans of all main structural items comprising the crane including the jib, tower, platform, gantry, bogies, slewing ring, pedestals, rails, stowage arrangements. (Note that pedestals and rails permanently attached to the vessel are classification items where the ship is classed with LR.)
- (c) Details of sheaves, axles, pivot pins, wheels, spreader beams, slewing ring, slewing ring bolts, and similar items.
- (d) Details of blocks, chains, shackles, hooks and other loose gear, indicating material, safe working load (SWL), proof loads (PL) and the standard to which they have been manufactured.
- (e) The size, construction, finish and certified breaking loads of steel wire ropes.
- (f) The material specification for steels to be used in the crane and pedestal construction.

3.2.2 In the case of diving systems covered by this Section additional information is to be submitted with respect to approval of the winches and electrical and control systems. This information is detailed in LR's *Rules and Regulations for the Construction and Classification of Submersibles and Diving Systems*. See also Chapter 7.

3.3 Mechanical lift docks

3.3.1 **Structural aspects.** The following plans are to be submitted for approval:

- (a) Structural plans of the platform.
- (b) Structural plans of the transfer system if it is required that this is to be included in the certification or class of the installation.
- (c) Upper and lower sheave housings.
- (d) Winch bedplate.
- (e) Rope or chain specification.
- (f) The material specification for steels used in the construction.

3.3.2 In addition the following plans and information are required for reference purposes:

- (a) Calculations clearly indicating the basis of design, nominal lifting capacity, maximum distributed load weights and centres of gravity of the component parts and any other relevant design criteria.
- (b) Platform assembly.
- (c) Arrangement of decking.
- (d) Rail arrangement and details.
- (e) Hoist and rigging arrangements.

■ Section 3

Plans and information to be submitted

3.1 Derrick systems

3.1.1 The following plans and information are to be submitted for approval:

- (a) A rigging plan clearly indicating the layout of the swinging derricks, heavy lifts derricks or union purchase systems and the position of the individual items of loose gear.
- (b) A diagram of forces for each derrick rig and in the case of union purchase working the working range and data specified in Chapter 2.
- (c) Scantling plans of masts and derrick posts and stays where fitted. (Note that these are classification items where the ship is classed with LR.)
- (d) Scantling plans of derrick booms including head and heel fittings.
- (e) Details of goosenecks, span and cargo swivels, guy eyeplates, and similar fittings.

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- (f) Cradle and block arrangements.
- (g) Welding specifications.

3.3.3 Mechanical, electrical and control aspects. The following plans are to be submitted for approval, (see also Chapter 7):

- (a) Diagrammatic plan of hydraulic or pneumatic systems (where fitted).
- (b) Plans of winch gearing, shafts, clutches, brakes, coupling bolts, welded drums, and similar items and their materials and stresses.
- (c) Plans of circuit diagram of electrical system, showing load currents and ratings of all electrical equipment, types and sizes of cables, rating type and make of all protecting devices.
- (d) Arrangement plan and circuit diagram of switchboard.
- (e) General arrangement of control centre.
- (f) Schematic diagrams of control panels.
- (g) Details of alarms and protection circuits.

3.3.4 In addition, the following information is required for reference purposes:

- Calculations of short circuit currents and main busbars, sub switchboard busbars and the secondary side of transformers.

3.4 Lifts and ramps

3.4.1 Structural aspects. The following plans are to be submitted for approval:

- (a) All main structural plans.
- (b) Details of sheaves and sheave supports.
- (c) Calculations clearly indicating the ratings, vehicle loads, wheel centres, tyre prints, working range and angles, design specification, weights and centres of gravity of the component parts.
- (d) Particulars of hydraulic rams and operating system, if fitted.
- (e) Reaving arrangements.
- (f) The size, construction, finish and certified breaking loads of ropes and chains.
- (g) The material specification for steels to be used in the construction.
- (h) Stowage arrangements.

3.4.2 In addition to the foregoing the following information is required with respect to lifts:

- (a) Typical layout including car construction and guide rail details.
- (b) Typical entrances.
- (c) Loading door fire test certificate.
- (d) Works test certificates for motors.
- (e) Typical wiring and explanatory diagrams including safety devices.

3.4.3 Mechanical, electrical and control aspects. Plans as listed in 3.3.3 and 3.3.4 are to be submitted.

Section

- 1 **General**
- 2 **Design criteria**
- 3 **Swinging derrick systems**
- 4 **Union purchase arrangements**
- 5 **Derrick cranes and derricks of special design**
- 6 **Derrick booms**
- 7 **Masts and derrick posts**
- 8 **Fittings for masts and derrick booms**

■ **Section 1**

General

1.1 Application

1.1.1 The requirements of this Chapter are to be complied with in cases where Lloyd's Register (hereinafter referred to as LR) is requested to issue a *Register of Ship's Cargo Gear and Lifting Appliances* for derrick systems.

1.1.2 Masts, derrick posts and similar supporting structures for cargo handling devices are classification items and are to comply with the relevant Sections of this Chapter whether or not LR is also requested to issue the *Register of Ship's Cargo Gear and Lifting Appliances*. See Pt 3, Ch 9,10 of the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as the Rules for Ships).

1.1.3 The requirements given in this Chapter are applicable to the following types of derrick system:

- Swinging derricks.
- Union purchase rigs.
- Derrick cranes.

Derricks of special design will be considered on the general basis of these requirements.

1.1.4 Typical arrangements of swinging derrick systems are shown in Fig. 2.1.1 and Fig. 2.1.2. These arrangements are given for illustration only and to indicate the nomenclature used in the systems.

1.2 Equivalents

1.2.1 Alternative arrangements or fittings which are considered to be equivalent to those specified in this Chapter will be accepted.

1.2.2 International or national standards will be considered as an alternative basis for approval provided LR is satisfied that these are at least equivalent to the criteria specified in this Chapter.

1.3 Additional calculations

1.3.1 Where the derrick system incorporates novel features LR may require additional calculations or model testing to be carried out. In such cases LR is willing to undertake calculations for designers and to make recommendations for model tests where required.

1.3.2 Direct calculations using computer programs may be used as an alternative to the calculation procedures of this Chapter. Where programs other than those available from LR are employed, the assumptions made and the calculation procedures used are to be submitted for approval. Where calculations using these procedures are made, the results are to be included with the plans submitted for approval.

1.4 Information to be submitted

1.4.1 The plans and information listed in Ch 1,3 are to be submitted for approval.

1.4.2 It is recommended the information be presented in the form of a *Cargo Gear Particulars Book* and that a copy be placed on board the ship. See Ch 9,2.1.

1.4.3 Plans of masts and derrick posts are required to be approved for classification purposes, and these plans together with a Rigging Plan and diagrams of forces are to be submitted in all cases, whether or not LR's *Register of Ship's Cargo Gear and Lifting Appliances* is to be issued.

1.5 Materials

1.5.1 Materials are to comply with the requirements of Chapter 8.

1.5.2 Steel for masts, derrick posts and associated items included in the classification of the hull is to comply with the requirements of the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials). The grade of steel is to be as follows:

Thickness in mm	$t \leq 20,5$	$20,5 < t \leq 25,5$	$25,5 < t \leq 40$	$40 < t$
Grade	A/AH	B/AH	D/DH	E/EH

1.5.3 Steel for derrick booms and associated fittings is to comply with LR's requirements as in 1.5.2 or with an appropriate national standard approved by LR as suitable for the intended purpose.

1.5.4 Steel castings and forgings are to be normalized or otherwise heat treated at a temperature and according to a method appropriate to the material and size of the item. Where fabricated items require to be heat treated, this is to be done after completion of all welding. The heat treatment is to be carried out in a properly constructed furnace with adequate temperature control.

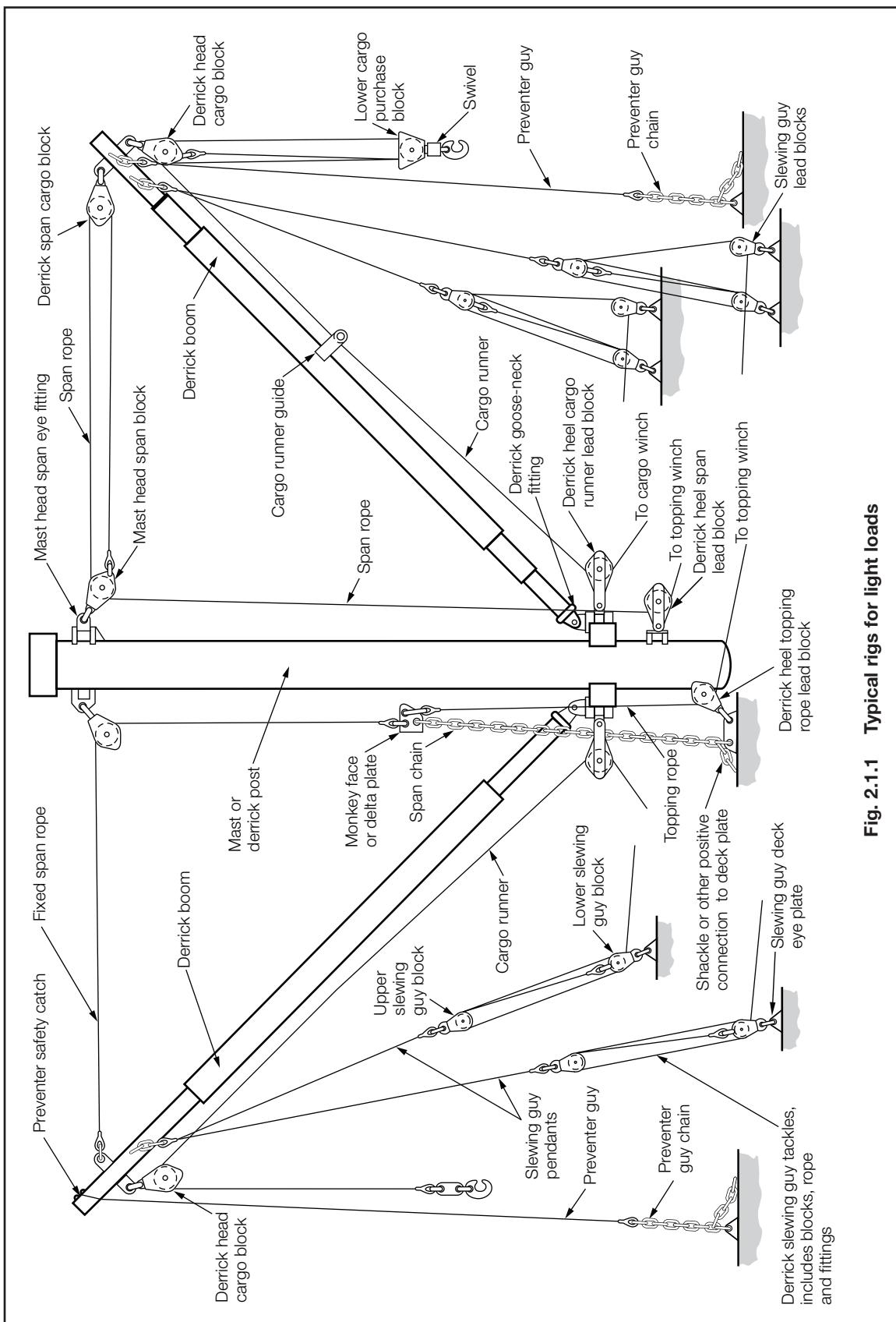
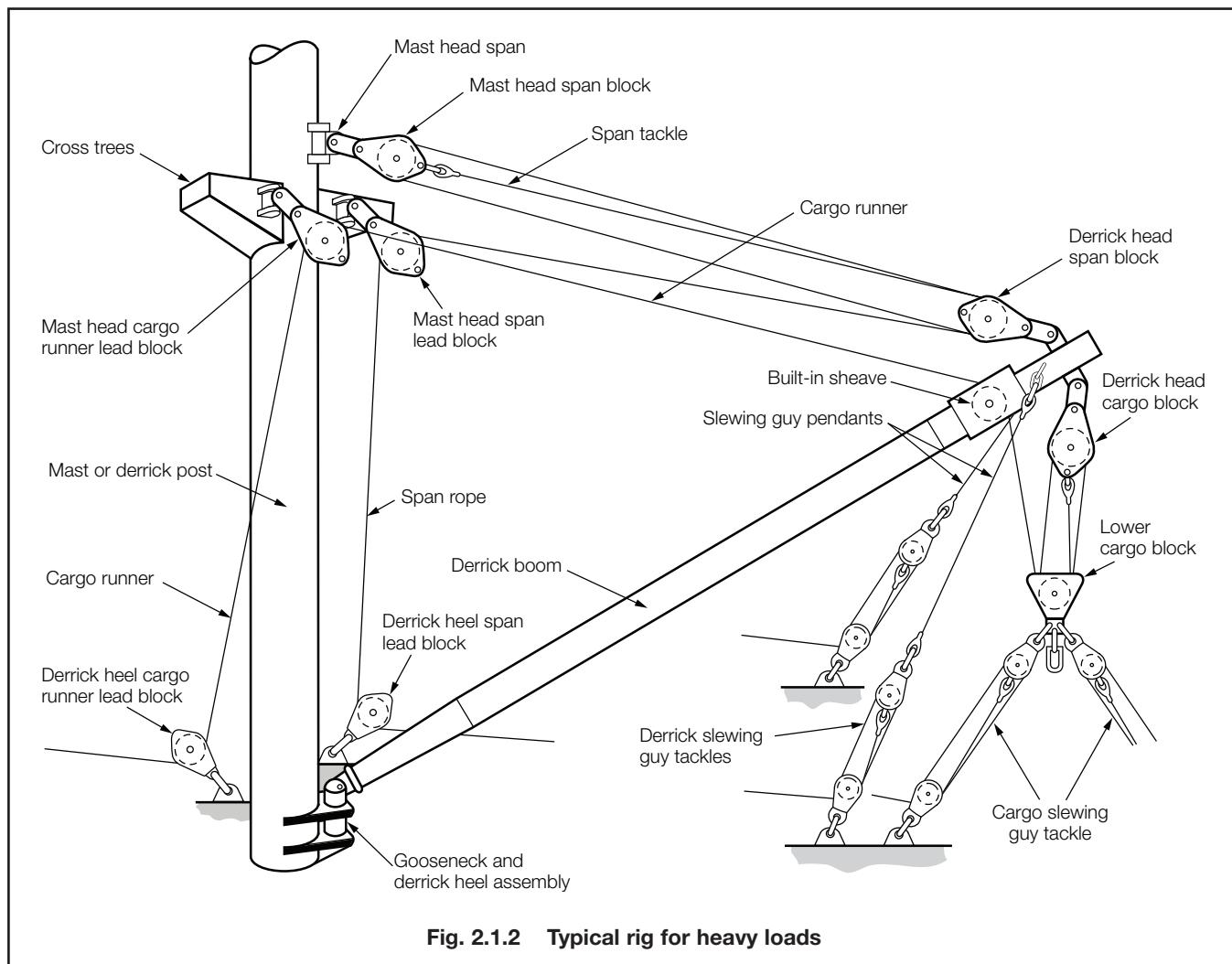


Fig. 2.1.1 Typical rigs for light loads

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Section 1



1.5.5 Cast, forged and fabricated items, are to be so designed and constructed as to minimize stress concentrations. Fabricated items are to be designed to ensure good penetration of welds and adequate accessibility for non-destructive examination as necessary.

1.6 Symbols and definitions

1.6.1 The nomenclature adopted for the principal items comprising the derrick system is shown on Fig. 2.1.1 and Fig. 2.1.2.

1.6.2 The following symbols are used throughout this Chapter:

- σ_y = the yield stress of the material under consideration, in N/mm² (kgf/mm²)
- σ_u = the ultimate tensile strength of the material under consideration, in N/mm² (kgf/mm²)
- L = the length of the derrick boom measured from the centre of the derrick heel pin to the centre of the derrick head span eye or equivalent position, in metres

H = the length of the mast, or derrick post measured from the centre of the derrick heel pin to the centre of the mast head span eye or equivalent position, in metres

S = the distance from the centre of the mast head span eye to the centre of the derrick head span eye, in metres

W = the load on the hook of the derrick system and usually to be taken as the safe working load of the system, in tonnes.

1.6.3 Remaining symbols are defined as they occur.

■ Section 2

Design criteria

2.1 Operating range for derricks

2.1.1 Calculations are to be made for derrick systems with the derrick booms at the maximum and minimum angles for which the system is to be certified. These angles are to be taken as follows:

- (a) Maximum angle to the horizontal: 70° generally, but a greater angle may be specified.
- (b) Minimum angle to the horizontal:
 - (i) SWL not exceeding 15 t: 30° generally, but a lesser angle may be specified. In no case is the angle to be less than 15°.
 - (ii) SWL exceeding 15 t: 30° generally, but a greater angle may be specified. In no case is the angle to be greater than 45°.

2.1.2 The length of the derrick boom is to be such as to give adequate coverage of the cargo hatch and sufficient outreach beyond the ship's side, within the limiting angles given in 2.1.1.

2.1.3 The lengths of derrick booms for union purchase systems are to be sufficient to provide the coverage of the hatch and outreach beyond the ship's side as required by 4.2.1. The angles of inclination of the booms are to remain within the limits given in 2.1.1.

2.2 Inclination of the ship

2.2.1 For swinging derrick and union purchase systems a basic angle of heel of 5° and a trim of 2° are assumed for the ship. Provided these angles are not exceeded, they may, generally, be ignored in the calculation of forces and tensions in the derrick system and in the masts and derrick posts.

2.2.2 The angles of heel and trim of the ship with its largest loaded derrick (or derricks if more than one can be used at one time) swung fully outboard are to be calculated. Where the calculation shows that the ship would have a greater angle of heel or trim than 5° or 2° respectively then the actual angles are to be taken into consideration. This calculation is NOT to be taken to mean that LR accepts responsibility for the stability of the ship. Stability is a matter to be agreed between the Builder, designer and Owner and may be subject to National Regulations.

2.2.3 For derrick cranes a basic angle of heel of 5° and a trim of 2° by the bow and by the stern is, generally, to be included in the calculations. Greater or lesser angles may be specified, however, provided these angles are clearly stated in the certificates.

2.3 Weight of boom and tackle

2.3.1 The weight of the derrick boom and tackle is to be included in the calculations for all union purchase rigs and for swinging derricks and derrick cranes where the SWL exceeds 15 t. Where available, the actual weight of the derrick boom and tackle is to be used. Alternatively an estimated value equal to 10 per cent of the SWL of the system when rigged as a swinging derrick or derrick crane is to be applied at the derrick boom head.

2.4 Friction allowance

2.4.1 For calculation purposes a combined allowance for sheave friction and wire stiffness is to be made as follows:

- Blocks with plain or bushed sheaves 5 per cent.
- Blocks with ball or roller sheaves 2 per cent.

2.4.2 The appropriate percentage is to be applied accumulatively to the parts of the rope supporting the load. Coefficients for estimating the rope tension are given in Table 2.2.1 which should be read in association with Fig. 2.2.1.

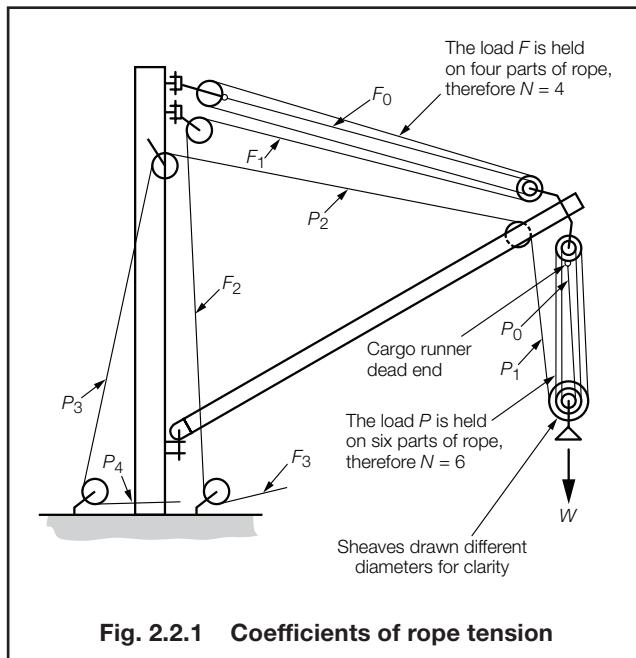


Fig. 2.2.1 Coefficients of rope tension

2.5 Factor of safety for ropes

2.5.1 Wire ropes are to have a breaking load not less than the maximum tension in the rope multiplied by a factor obtained from Table 2.2.2.

2.5.2 Fibre ropes used in derrick systems, where permitted, are to have a breaking load not less than the maximum tension in the rope multiplied by 8.

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Table 2.2.1 Coefficients of rope tensions

Number of parts supporting the load	Friction allowance per sheave %	Static rope pull	Hoisting					Lowering						
			P_0/F_0	P_1/F_1	P_2/F_2	P_3/F_3	P_4/F_4	P_5/F_5	P_0/F_0	P_1/F_1	P_2/F_2	P_3/F_3	P_4/F_4	P_5/F_5
1	2	1,00	—	—	1,02	1,04	1,06	1,08	—	—	0,98	0,96	0,94	0,92
2	2	0,500	0,495	0,505	0,515	0,525	0,536	0,547	0,505	0,485	0,476	0,467	0,457	0,401
3	2	0,333	0,327	0,340	0,347	0,354	0,361	0,368	0,340	0,327	0,320	0,314	0,308	0,302
4	2	0,250	0,243	0,258	0,263	0,268	0,273	0,279	0,258	0,243	0,238	0,233	0,229	0,224
5	2	0,200	0,192	0,208	0,212	0,216	0,221	0,225	0,208	0,192	0,188	0,185	0,181	0,178
6	2	0,167	0,159	0,175	0,179	0,182	0,186	0,189	0,175	0,159	0,155	0,152	0,149	0,146
7	2	0,143	0,135	0,152	0,155	0,158	0,160	0,164	0,152	0,135	0,132	0,129	0,127	0,124
8	2	0,125	0,105	0,117	0,134	0,137	0,139	0,142	0,134	0,117	0,114	0,112	0,110	0,108
9	2	0,091	0,103	0,120	0,123	0,125	0,128	0,130	0,120	0,103	0,101	0,099	0,097	0,095
10	2	0,070	0,082	0,100	0,102	0,104	0,106	0,108	0,100	0,082	0,081	0,079	0,077	0,076
11	2	0,091	0,075	0,093	0,095	0,097	0,099	0,100	0,093	0,075	0,073	0,072	0,070	0,069
12	2	0,083	0,063	0,075	0,093	0,095	0,097	0,100	0,093	0,063	0,060	0,057	0,054	0,052
13	2	0,077	0,057	0,068	0,086	0,088	0,090	0,092	0,086	0,068	0,066	0,064	0,063	0,062

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Table 2.2.2 Factors for wire ropes

Item	Factor
(1) Running rigging:	
Cargo runner	10^4
Span tackle	$(8.85 \times \text{SWL}) + 1910$
Slewing guys	but not greater than 5 nor less than 3
Preventer guys	
Schooner guys	
(2) Standing rigging:	
Mast stays	As for running rigging but need not exceed 3.5
NOTE	
SWL is the safe working load of the derrick or derrick crane with which the rope is to be used. For standing rigging, SWL is the highest safe working load of any derrick or derrick crane supported by the mast.	

Section 3

Swinging derrick systems

3.1 General

3.1.1 A swinging derrick system comprises a derrick boom pivoted at its heel and supporting the load from a head fitting. The boom is raised or lowered (luffed) by means of a span rope between the boom head and a suitable fixed point usually a mast or derrick post. The boom is moved laterally (slewed) by guy ropes attached at the boom head.

3.1.2 Swinging derricks may be divided into two categories:

- Light derricks, having a safe working load of 15 t or less.
- Heavy derricks having a safe working load exceeding 15 t.

3.2 Operating conditions

3.2.1 Calculations are to be made with the derrick boom at its lowest and highest operating angles to the horizontal, subject to the requirements of 2.1.1.

3.2.2 Where more than one arrangement of rig is proposed for the derrick, calculations are to be made for each arrangement.

3.3 Force diagrams and calculations

3.3.1 Where force diagrams are prepared, the vertical load at the derrick boom head is to be taken as the SWL of the rig plus an allowance for the weight of the boom and tackle as required by 2.3.

3.3.2 The tension in the cargo runner is to be calculated using the factors given in Table 2.2.1 for the appropriate friction allowance for the blocks and number of parts of the runner in each section of the purchase.

3.3.3 Using this information, a polygon of forces may be drawn and the resultant force in the span tackle and thrust in the derrick boom determined.

3.3.4 A typical set of force diagrams is shown in Fig. 2.3.1.

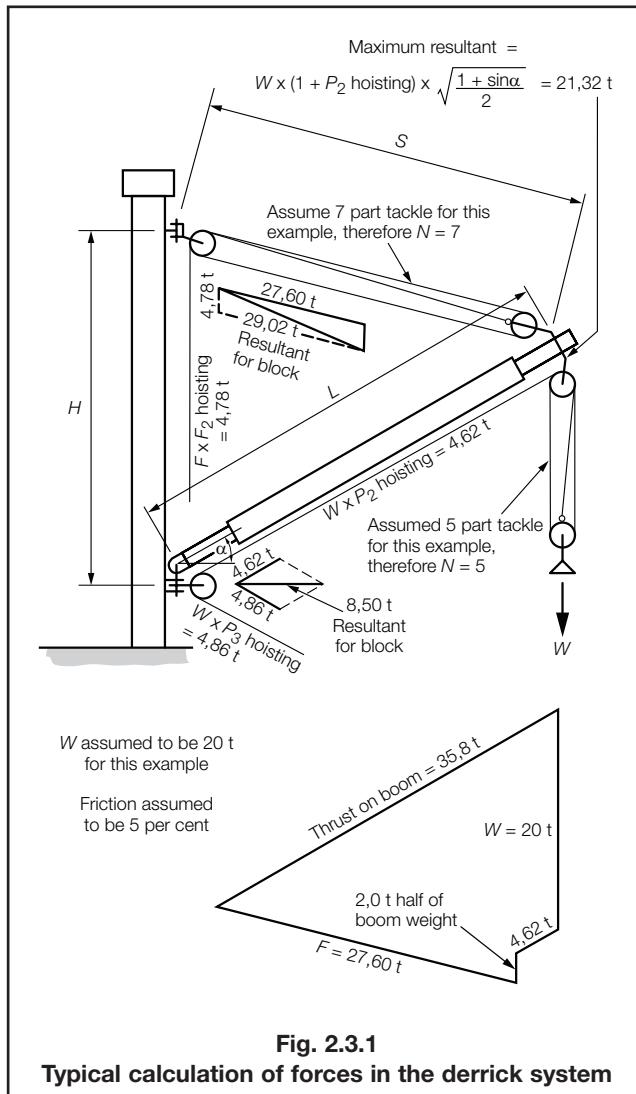


Fig. 2.3.1
Typical calculation of forces in the derrick system

3.3.5 Where the cargo runner is parallel to the span tackle between the boom head and mast head, the tension in the runner provides partial support for the system. This force, called the 'span relief' is deducted from the total span force in order to determine the load in the span tackle. Consequently, in order to find the maximum load in the span tackle, the system is to be considered in lowering operation and the span relief is $W \times P_2$ lowering. All other forces in the rig are to be calculated for the hoisting operation.

3.3.6 The required breaking load of each rope is found by multiplying the maximum calculated tension by the appropriate factor of safety from Table 2.2.2.

3.3.7 The resultant loads in each of the blocks in the rig may be determined by drawing the appropriate polygons of forces as shown in Fig. 2.3.1.

3.3.8 The resultant forces in the system may be determined by direct calculation as an alternative to the preparation of force diagrams.

3.3.9 Fittings, loose gear and ropes are to comply with the requirements of Chapter 6.

■ Section 4

Union purchase arrangements

4.1 General

4.1.1 Where the derricks are arranged for operation in union purchase the maximum resultant loads in the system are to be determined in accordance with the requirements of this Section.

4.1.2 The scantlings and arrangements of the derrick system are to be determined for union purchase operation and for operation as single slewing derricks. Each part of the rig is to be suitable for the most severe loading to which it may be subjected.

4.1.3 The union purchase rig is, generally, to be designed so that operation is possible on either side of the ship. A typical rig is shown in Fig. 2.4.1.

4.1.4 Union purchase rigs may be designed on the basis of either:

- (a) minimum headroom below the triangle plate; or
- (b) maximum included angle between the cargo runners.

4.1.5 The following criteria are to be complied with at all times:

- (a) Minimum operating angle of either derrick is to be not less than 15° to the horizontal, and it is recommended this angle is not less than 30°.
- (b) Minimum headroom to the triangle plate is to be not less than 4,0 m where the SWL(U) of the rig does not exceed 2,0 t, or 5,0 m for higher values of SWL(U).
- (c) The maximum included angle between the cargo runners is not to exceed 12°.
- (d) The outreach beyond the midship breadth of the ship is to be not less than 4,0 m.

4.1.6 The minimum headroom is defined as the least vertical distance, at any stage in the operating cycle of the rig, from the highest point of the ship's deck structure (usually the top of the hatch coaming or the ship side bulwark or rails) to the centre of the triangle plate.

4.2 Working range of the rig

4.2.1 The derrick booms are to be of sufficient length and to be so positioned as to cover the required working area of the hatch while complying with the criteria given in 4.1.5.

4.2.2 For this purpose the booms are to be such that the boom heads may be located at the positions listed in Table 2.4.1. These arrangements are illustrated in Fig. 2.4.2(a) and (b) for hatches with one pair and two pairs of derricks respectively.

Table 2.4.1 **Boom head positions for union purchase calculations**

Boom and direction	Symbol	Number of pairs of booms at the hatch	
		One	Two
Outboard boom:			
Transverse	y_o	4	4
Longitudinal	x_o	$0,25l_h$	$0,20l_h$
Inboard boom:			
Case 1 Transverse	y_i	1	1
Longitudinal	x_i	$0,75l_h$	$0,67l_h$
Case 2 Transverse	y_i	$0,25b_h$	$0,25b_h$
Longitudinal	x_i	$0,375l_h$	$0,33l_h$
NOTES			
1. For illustration of positions and symbols used, see Fig. 2.4.2.			
2. Case 2 is applicable to operation in the maximum included angle mode only.			
3. l_h and b_h are defined as the length and breadth respectively of the hatch openings, in metres.			

4.2.3 Calculations of the forces and resultant loads in the system are to be made as follows:

- (a) Based on maximum headroom:

Outboard boom, see Table 2.4.1.
Inboard boom, see Table 2.4.1, Case 1.

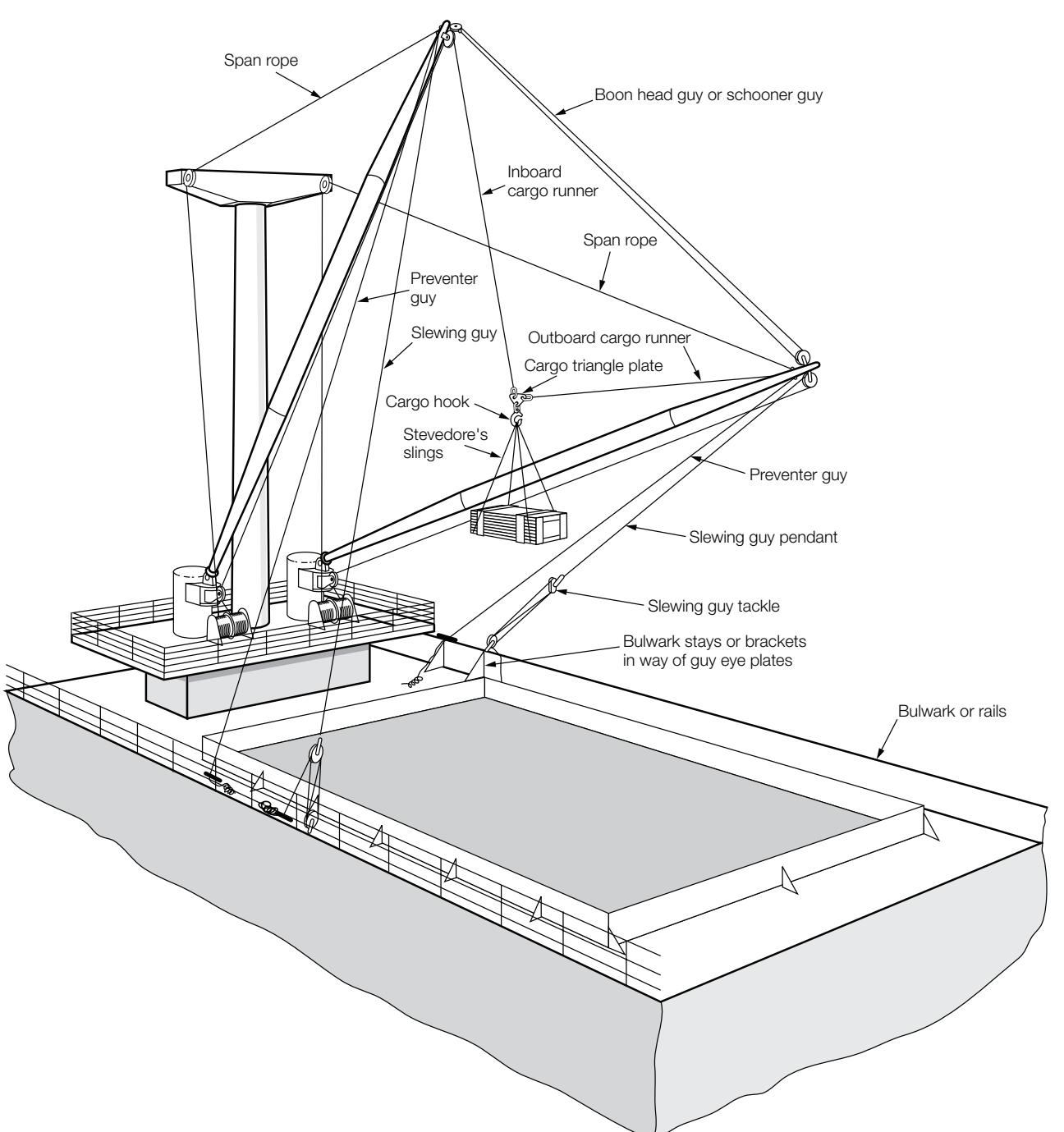
- (b) Based on maximum included runner angle:

Outboard boom, see Table 2.4.1.
Inboard boom, see Table 2.4.1, Cases 1 and 2 (that is, two calculations are required).

4.2.4 Where, at the request of the Owner, the rig is to operate over a working range different from that given in 4.2.2, including instances where the rig is designed for use in one fixed position only, calculations are to be made for the extreme positions of the specified range. The boom positions are to be clearly defined in the *Register of Ship's Cargo Gear and Lifting Appliances*. In all instances the arrangement is to comply with the limiting criteria given in 4.1.5.

4.2.5 It may be assumed that the maximum forces will be associated with the extreme positions of the rig. Intermediate positions within the working range need not, in general, be examined.

4.2.6 The derrick booms are to be restrained by the use of preventer guys which are to be attached to eyeplates at the boom head or looped over the boom. The slewing guys are to be slackened off once the rig is set up and only the preventer guys are to be taken into account in the calculation of forces in the rig.

**Fig. 2.4.1 Typical union purchase rig**

4.2.7 It is recommended that the deck eyeplate for the preventer to the inboard derrick should be approximately abreast the derrick head. The eyeplate for the preventer to the outboard derrick is to be positioned so as to obviate the risk of jack-knifing, see Fig. 2.4.5, and to avoid excessive guy tension.

4.2.8 The boom heads are to be connected by a boom head or schooner guy, the safe working load of which is to be as required by 8.4.6. Alternative arrangements will be considered.

4.3 Calculation of forces

4.3.1 The dimensions and other particulars required for the calculation of forces in the rig are indicated in Fig. 2.4.3.

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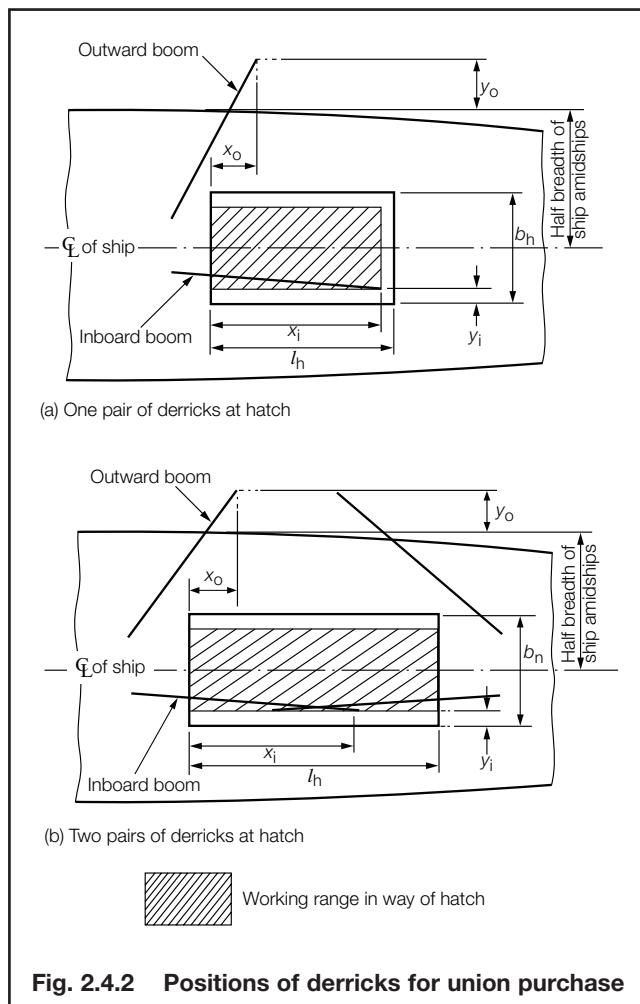


Fig. 2.4.2 Positions of derricks for union purchase

4.3.2 Where the forces are to be determined by the construction of force diagrams it is recommended that the following procedure be adopted, corresponding to the parts of the typical diagrams as labelled in Fig. 2.4.4:

- Projected plan of the rig.
- True side elevations of the derrick booms.
- Lines of the cargo runners at the minimum headroom position.

4.3.3 The force diagrams may be constructed on these geometrical diagrams as follows. For illustration, values corresponding to a unit load on the rig are shown on Fig. 2.4.4.

- The runner tensions and components of tension at the boom heads are determined from Fig. 2.4.4(c).
- The horizontal component of runner tension is marked off and the horizontal components of boom thrust and of guy tension are derived from Fig. 2.4.4(a).
- The vertical component of boom thrust and the guy tension may now be determined, see Fig. 2.4.4(a).
- The compression in the boom and the tension in the span rope are determined from Fig. 2.4.4(d) using the horizontal component of boom thrust and the total of the vertical forces, which are:
 - Vertical component of runner tension, as in (a).
 - Vertical component of guy tension, as in (c).
 - Weight of boom and tackle, see 2.3.1.

4.3.4 Where a diagram of the character shown in Fig. 2.4.5 is obtained, that is where the diagram does not 'close', the boom is in danger of jack-knifing. The boom will be in danger of jack-knifing if the total vertical load is less than $(\text{span tension} \times \tan \alpha)$, where α is the angle of the boom to the horizontal. Where this situation arises the eyeplates for the preventer guys are to be repositioned. In general, it is recommended that the position of the guy eyeplate for the outboard boom is such that the load due to the vertical components of the runner and guy forces (but not the boom weight) is at least equal to $\text{span tension} \times \tan \alpha$.

4.3.5 As an alternative to the graphical procedure, the forces in the rig may be determined by direct calculation.

Vertical distances above datum level are positive
Vertical distances below datum level are negative

H = From heel pin to span eye
 L = From heel pin to span eye
 Z =
 N = Hatch or bulwark
 Datum level

N is to be measured at half length of hatch
 N may be above or below datum level

H = Eye plate for main guy
 L = Eye plate for main guy

J =
 M =
 K =
 F =
 G =
 C =
 A =
 B =
 E =
 I_h =
 $0,5x_i$ =
 $0,25b_h$ =
 Hatch
 x_i =
 b_h =
 $1m$ =
 G of ship

SWL of runner.....

No. of available booms.....

Hatch No..... SWL (U).....

Is hatch forward or aft of mast or derrick post?..... SWL of boom.....

Half breadth of ship amidships..... Name or Yard No. of ship.....

Distance guy eyes from datum level

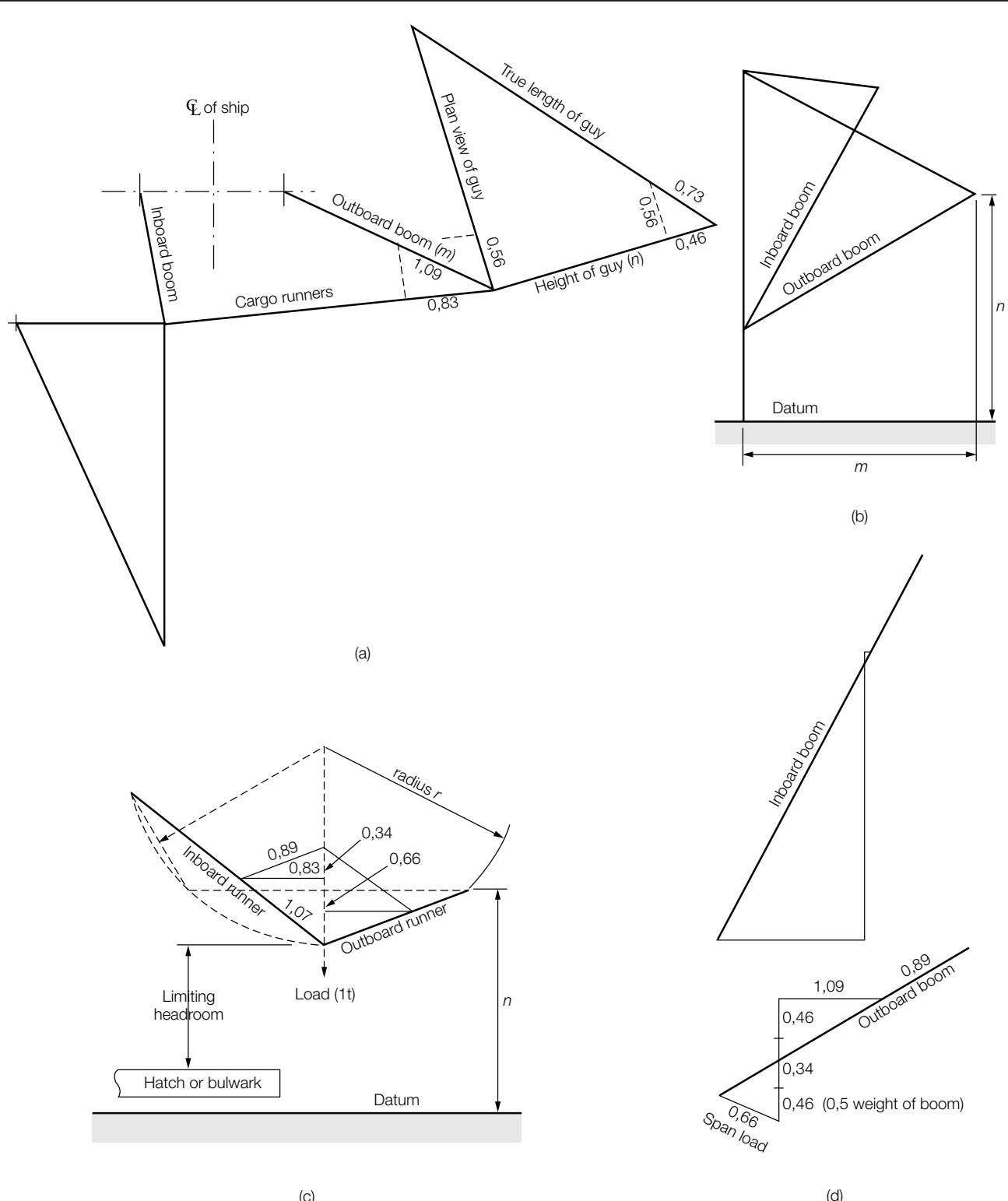
Inboard boom.....

Outboard boom.....

Fig. 2.4.3 Typical data sheet

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**Fig. 2.4.4 Typical union purchase calculations**

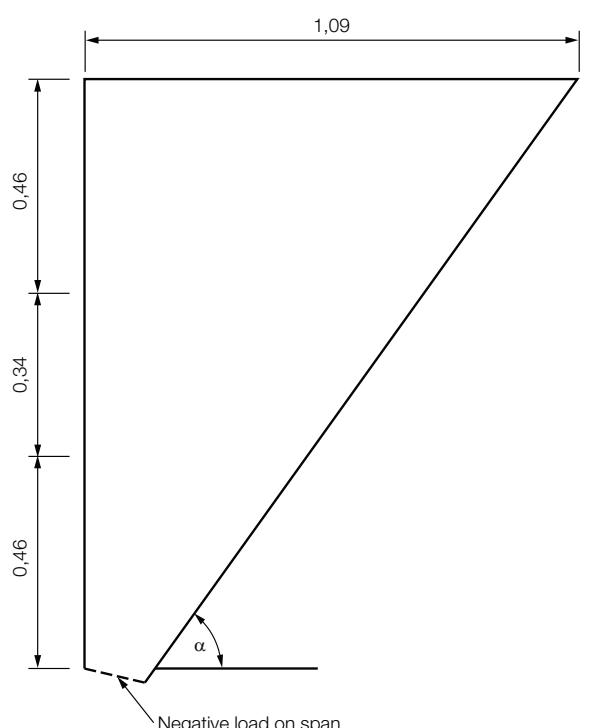


Fig. 2.4.5
Form of diagram when beam is in danger of
jack-knifing

■ Section 5

Derrick cranes and derricks of special design

5.1 General

5.1.1 In general, a derrick crane may be described as a conventional derrick fitted with one of the following modifications:

- (a) Twin span tackles so designed that the derrick can be slewed without the use of separate guys.
- (b) A system for topping (luffing) the derrick boom other than by means of span ropes.
- (c) The cargo and/or the span winches built into the derrick boom and moving with it.
- (d) A system for slew ing the derrick boom by applying a torque to a slew ring or trunnion.

Where more than one of the above modifications is fitted the system will, normally, be considered as a deck crane and the requirements of Chapter 3 will apply.

5.1.2 Derricks of special design but not designated as derrick cranes are to comply with the requirements of this Section in so far as they are applicable.

5.1.3 Attention is drawn to the fact that many of the designs and variations of design incorporated in derrick cranes and special derrick systems incorporate patent features.

5.1.4 Derrick cranes and derricks of special design are to be examined for the operating range and angles of inclination of the ship as specified in Section 2. Force diagrams or calculations are to be prepared as required by Section 3. More detailed calculations may, however, be required to support proposals for unusual systems.

5.2 Twin span tackles

5.2.1 Twin span tackles are to include:

- (a) Two separate span tackles each attached to the head of the boom, directly or via outriggers, and operated by independent winches.
- (b) Two span tackles led to a topping winch and a slewing winch. The topping winch shortens equally on both spans and the slewing winch shortens one span while paying out the other, see Fig. 2.5.1.

The two sections of the tackles may be attached to the cross trees of a mast or they may be fitted to two separate derrick posts. Where two separate posts are used, the boom is sometimes arranged so that it can pass through the vertical position between the posts and so be available to work hatches both forward and aft of the posts.

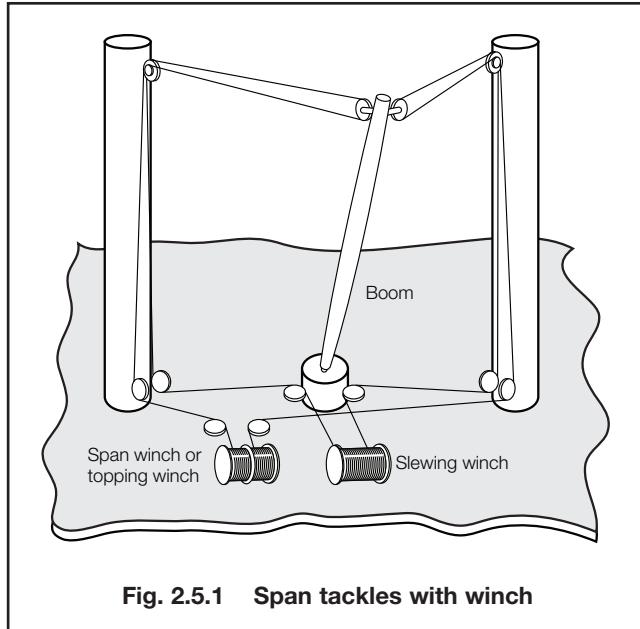


Fig. 2.5.1 Span tackles with winch

5.2.2 Where twin span tackles are fitted they are to be so arranged that the minimum distance of the span tackle from the vertical through the boom gooseneck is not less than one-ninth of the boom length. This distance is to be measured horizontally at right angles to the line of action of the span tackle, or section of span tackle under consideration, see Fig. 2.5.2. This minimum separation can be achieved by one or more of the following means:

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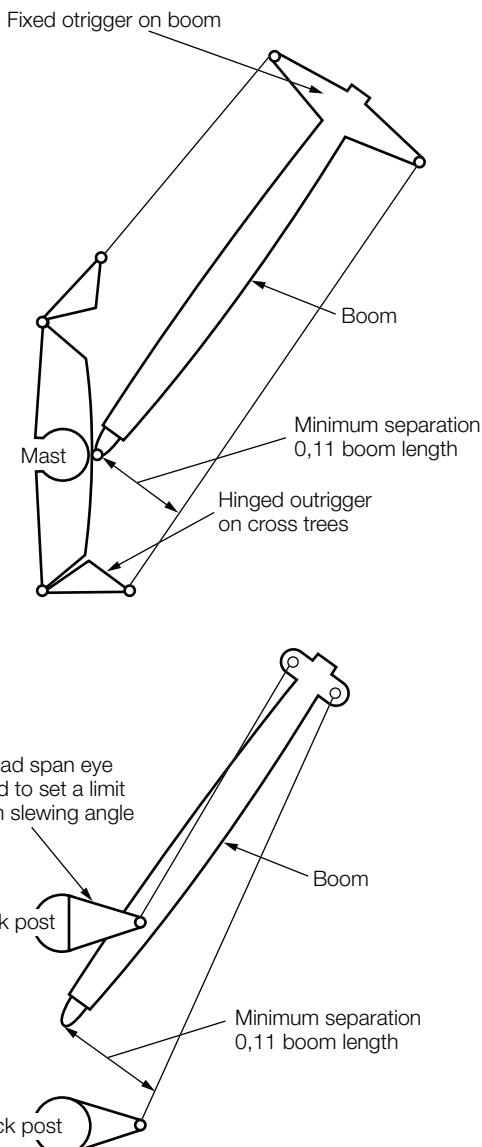


Fig. 2.5.2 Minimum separation

- (a) by limiting the slewing angle of the boom; or
- (b) by fitting outriggers to the boom head; or
- (c) by fitting hinged or fixed outriggers, or their equivalent; to the derrick posts, mast house or cross tree; or
- (d) by a combination of one or more of the above.

5.2.3 Alternatively the stability of the system may be demonstrated by calculation or by model tests.

5.2.4 Where the slewing angle of the boom is to be restricted this can be done by moving the position of the mast head span eyeplate away from the transverse plane through the gooseneck into a position that will be vertically above the derrick boom when the boom is in its limiting position. Alternatively limit switches may be installed to provide automatic cut-out of the slewing system. Limiting the slewing angle of the boom by means of a stop fitted to the boom heel or by allowing the boom to come up against a shroud or other obstruction cannot normally be recommended as these methods tend to induce large transverse bending moments in the boom or to cause local indentations and consequential failure of the boom tube.

5.2.5 In general, where twin span tackles are fitted the strength of each is to be sufficient to support the boom plus the safe working load in the boom's fully outboard position. Where, however, it can be shown that it is not possible for either span tackle to become slack in service, the strength of each tackle may be based on the maximum calculated span tension but is to be taken as not less than two-thirds of the total span tension. Calculations in this respect are to be submitted by the manufacturer of the derrick crane.

5.2.6 Where the derrick boom is fitted with a cross-head and the span tackles are each connected by strops to both ends of the crosshead, then the required breaking load of each of the strops may be based upon 80 per cent of the maximum load in the span tackle.

5.3 Slewing guys

5.3.1 Slewing guys may be fitted in addition to twin span tackles and may take any one of the following forms:

- (a) Guys of the normal type.
- (b) Guys which are so rigged that topping the boom will not alter the transverse position of the boom head relative to the centreline of the ship.
- (c) One or more bights of the span wire led down from the boom head span block, round a block at deck or bulwark level and back up to the boom head span block again.

5.3.2 Where a guy is led from an eyeplate on the deck around a block at the boom head and then to an eyeplate on the mast, a calculation or diagram of forces is to be prepared with the boom in its highest working position in order to check that the boom is not liable to jack-knife.

5.3.3 The required safe working load of the slewing guys of normal type are to be determined from 8.4 on the basis of the SWL of the derrick system. Where a derrick crane is of the type described in 5.1.1(c) the nominal SWL for this purpose is to be increased by 25 per cent.

5.4 Derrick booms

5.4.1 The scantlings of derrick booms are, generally, to be determined in accordance with Section 6.

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Section 6 Derrick booms

6.1 General

6.1.1 The requirements of this Section are applicable to the following types of tubular derrick boom:

- (a) **Parallel boom.** A boom which is of uniform diameter and thickness over its full length.
- (b) **Tapered boom.** A boom which has a mid-section of uniform diameter and thickness welded to tapered end sections.
- (c) **Stepped boom.** A boom which has a mid-section of uniform diameter and thickness reducing towards the ends in one or more steps. The change of section may be obtained by cressed, lapped or stepped construction.

6.1.2 Proportions for tapered and stepped derrick booms are illustrated in Fig. 2.6.1. Alternative arrangements will, however, be accepted where it can be shown that the resulting strength of the boom is adequate. Derricks of unusual design or incorporating special features will be considered on the general basis of these requirements.

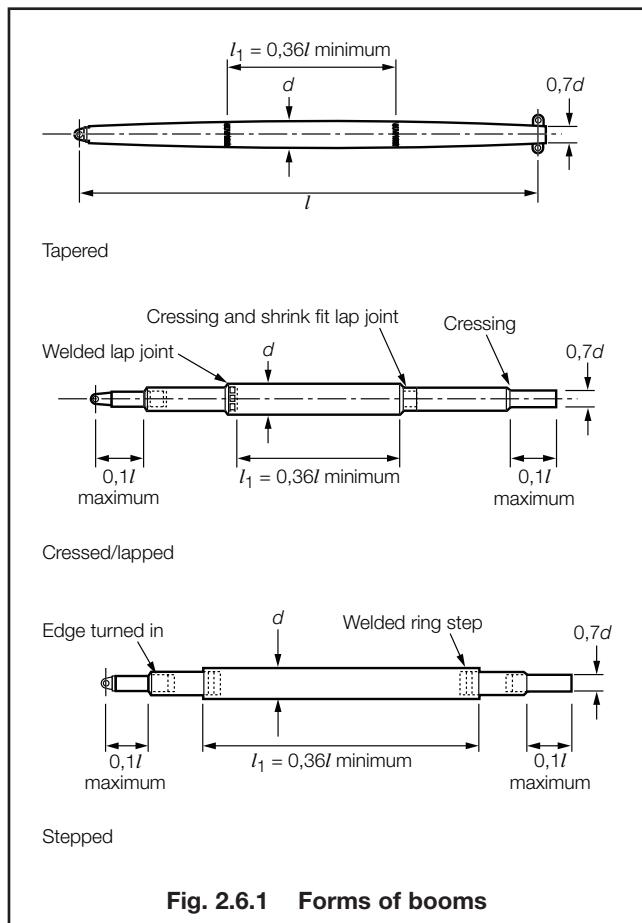


Fig. 2.6.1 Forms of booms

6.1.3 The scantlings of derrick booms are to be determined on the basis of the axial thrust and the maximum combination of bending moments applied to the boom, as derived from the force diagrams and calculations for the derrick system.

6.1.4 Steel for derrick booms is to comply with the requirements of 1.5.3. Derrick booms intended for a SWL of 60 t or more are to be suitably heat treated after welding where considered necessary. For mild steel booms this may normally be confined to the region of highly loaded welded connections. The requirements for higher tensile steel booms will depend on the materials specification.

6.2 Determination of forces

6.2.1 The axial thrust in the derrick boom is to be determined from the force diagrams or calculations of forces for the derrick system, see Sections 3, 4 and 5.

6.2.2 The bending moments acting on the boom are to be calculated for conditions with the boom in its lowest and its highest working positions.

6.2.3 The determination of vertical end bending moments for typical derrick head arrangements is illustrated in Fig. 2.6.2. The bending moment is to be calculated about the point of intersection of the axis of the boom with the line joining the points of action of the cargo and span loads, and may be taken as reducing linearly from this point to zero at the derrick heel.

6.2.4 For built-in sheaves, where the sheave pin intersects the axis of the boom, the value of h is to be taken as zero.

6.2.5 Horizontal bending moments arising from slewing or preventer guys attached to the derrick boom head may, generally, be neglected.

6.2.6 Where the derrick is fitted with a crosshead or outrigger, consideration is to be given to the bending and torsional moments which may arise where the span force is not equally distributed between the span tackles. In general, the boom is to be designed to resist the bending moments induced when supported by one span tackle only.

6.3 Boom scantlings

6.3.1 The following symbols are used in this sub-Section:

d = external diameter of the boom in the mid length region, in mm

l = overall length of the derrick boom, in mm

l_1 = length of the parallel part of the boom, in mm

r = effective radius of gyration of the boom, in mm

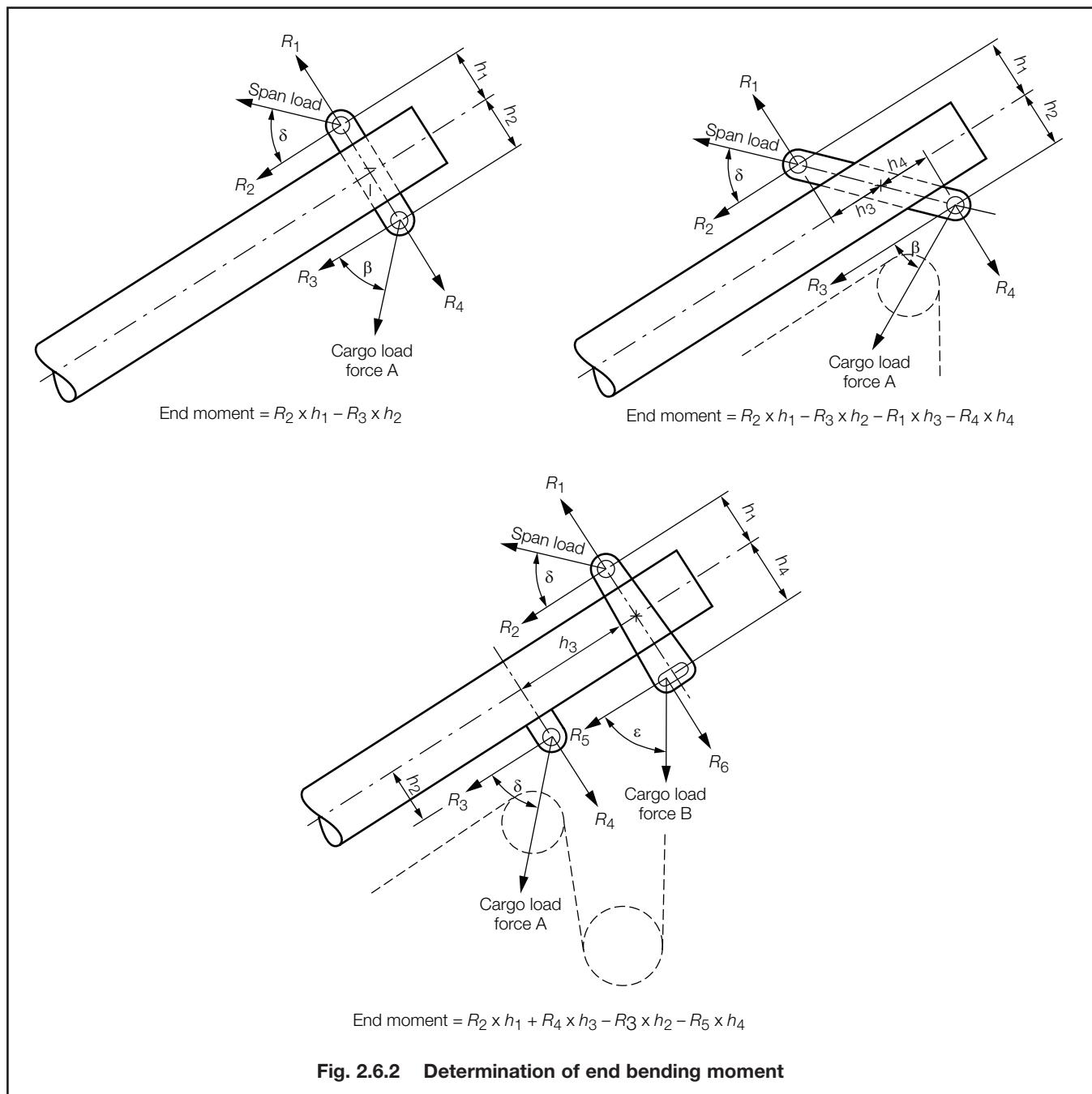
t = wall thickness of the boom in the mid length region, in mm

A = cross-sectional area of material of the boom in the mid length region, in mm^2

A_e = cross-sectional area of material of the boom at the boom head, in mm^2

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**Fig. 2.6.2 Determination of end bending moment**

I = moment of inertia of the boom in the mid length region, in mm^4

I_e = moment of inertia of the boom at the head, in mm^4

Z = section modulus of the boom in the mid length region, in mm^3

Z_e = section modulus of the boom at the boom head, in mm^3

6.3.2 The slenderness ratio $\left(\frac{I}{r}\right)$ of the boom is not to exceed 180. It is recommended that the slenderness ratio be less than 150.

6.3.3 The wall thickness of the boom at mid length is to be not less than:

$$t = 2 + \frac{d}{70} \text{ mm}$$

The wall thickness at ends is to be such that the cross-sectional area of material is not less than $0,75A$.

6.3.4 The moment of inertia at the derrick head, I_e , is to be not less than $0,40I$.

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6.3.5 Where the derrick boom is tapered or stepped an effective radius of gyration, r , is to be determined from:

$$r = \sqrt{\frac{cI}{A}} \text{ mm}$$

where

$$c = 0,17 + 0,33u + 0,5 \sqrt{u} + \frac{l_1}{l} (0,62 + \sqrt{u} - 1,62u)$$

$$u = \sqrt{\frac{I_e}{I}}$$

Where l_1 is greater than $0,5l$ the value of c is to be obtained by interpolation between c calculated for $l_1 = 0,5l$ and $c = 1$ at $l_1 = 0,8l$.

6.3.6 The bending moment acting on the boom is to be taken as:

(a) At mid length, the sum of:

(i) The self-weight bending moment, taken as:

$$M_{sw} = 9,30 \times 10^{-6} A l^2 \text{ Nmm}$$

(ii) One half the applied bending moment in the vertical plane acting at the boom head.

(b) At the boom head:

The applied bending moment in the vertical plane, see 2.3.1 and 6.2.3.

6.3.7 Where significant horizontal bending moments are likely to be applied to the boom they are to be taken into account in the calculation.

6.3.8 The critical stress, σ , in N/mm² for the derrick boom is to be determined from:

$$\sigma_c = \frac{\sigma_y + (1 + \eta) \sigma_e}{2} - \sqrt{\left(\frac{\sigma_y + (1 + \eta) \sigma_e}{2}\right)^2 - \sigma_e \left(\sigma_y - \frac{1,2M}{Z}\right)}$$

where

$$\eta = 0,003 \frac{l}{r}$$

$$\sigma_e = \frac{\pi^2 E}{\left(\frac{l}{r}\right)^2} \text{ N/mm}^2$$

$$E = 2,06 \times 10^5 \text{ N/mm}^2 \text{ for steel}$$

M = the vector sum of applied bending moments, in N mm, derived from 6.3.6(a) or (b) and 6.3.7.

6.3.9 The maximum allowable thrust, T , in the boom is to be determined from the critical stress and a factor of safety, F , such that:

$$\sigma_c = \frac{\sigma_c A_x}{F} \times 10^{-4} \text{ tonnes}$$

where

A_x = the cross-sectional area of material at the section under consideration, in mm²

F = (i) at mid length

$$1,85 + \left(\frac{90}{35 + T}\right) \text{ but } 2,333 \leq F \leq 3,85$$

- (ii) at ends 1,85
- (iii) at intermediate positions:
by parabolic interpolation between the values at mid-length and at the boom head.

6.3.10 Where T lies between 10 and 160 tonnes, the value T for the mid length region may be determined from:

$$T = \sqrt{\left(\frac{154,75 \times 10^4 - \sigma_c A}{3,7 \times 10^4}\right)} + 18,92 \times 10^{-4} \sigma_c A - \left[\frac{154,75 \times 10^4 - \sigma_c A}{3,7 \times 10^4}\right] \text{ tonnes}$$

6.3.11 For the purpose of making a first approximation to the required scantlings for a boom, thrust coefficients are tabulated in Tables 2.6.1 and 2.6.2. The maximum allowable thrust, before making allowance for applied bending moments, is approximately:

$$\text{Thrust} = (t - 1,5) \times \text{coefficient tonnes}$$

Having selected a suitable boom diameter and wall thickness, the allowable thrust, taking account of applied bending moment, is to be determined in accordance with the method given above.

6.4 Construction details

6.4.1 In way of head and heel fittings, the wall thickness is to be not less than 5,0 mm or 0,025 of the tube diameter at that point, whichever is the greater. Proposals to fit stiffening in lieu of increased plate thickness to meet this requirement will be considered.

6.4.2 Where internal access for welding of the derrick tube is impracticable, backing bars of thickness not less than 4 mm are to be fitted in way of butt welds, or alternative means of obtaining full penetration welds are to be agreed.

6.4.3 Lap joints are to be not less than half the boom diameter at that point in extent. Where the lap is welded, this is to be achieved by slot welds of at least 75 mm length and twice the boom wall thickness (but not less than 25 mm) in breadth. Where step joints are adopted the inner tube is to extend into the outer tube a distance of not less than the diameter of the outer tube or 450 mm, whichever is the lesser. The end of the inner tube is to be stiffened by a steel ring not less than 40 mm in width and of thickness sufficient to give a sliding fit within the outer tube, see Fig. 2.6.3.

6.4.4 Welds are to be sound, uniform and substantially free from defects. The throat thickness of fillet welds on lapped joints is to be not less than 0,7 times the thickness of the inner plate forming the joint.

6.4.5 Derrick booms are to be sealed to minimize corrosion to their internal surfaces. Where practicable, derrick booms are to be painted internally or otherwise treated to reduce corrosion, after the completion of all welding.

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Table 2.6.1 Boom thrust coefficients (mild steel $\sigma_y = 235 \text{ N/mm}^2$)

Boom diameter, in mm	Boom length, in meters										
	6,0	7,5	9,0	10,5	12,0	13,5	15,0	16,5	18,0	19,5	21,0
152,4	1,36	0,94	0,68	—	—	—	—	—	—	—	—
159,0	1,55	1,06	0,77	—	—	—	—	—	—	—	—
165,1	1,73	1,18	0,86	—	—	—	—	—	—	—	—
168,3	1,83	1,25	0,91	0,70	—	—	—	—	—	—	—
177,8	2,14	1,48	1,07	0,82	—	—	—	—	—	—	—
193,7	2,71	1,93	1,39	1,05	0,83	—	—	—	—	—	—
219,1	3,71	2,78	2,05	1,53	1,19	0,96	—	—	—	—	—
244,5	4,78	3,77	2,87	2,19	1,70	1,34	1,10	—	—	—	—
267,0	5,75	4,72	3,72	2,88	2,25	1,79	1,45	1,20	—	—	—
273,0	6,02	4,99	3,96	3,09	2,42	1,93	1,56	1,29	—	—	—
298,5	7,14	6,14	5,05	4,05	3,22	2,58	2,10	1,73	1,45	—	—
323,9	8,27	7,30	6,21	5,12	4,15	3,36	2,74	2,27	1,90	1,61	1,38
355,6	9,69	8,77	7,71	6,57	5,47	4,51	3,72	3,09	2,60	2,20	1,89
368,0	10,25	9,35	8,30	7,16	6,03	5,01	4,16	3,47	2,91	2,47	2,18
406,4	11,99	11,14	10,15	9,03	7,85	6,71	5,67	4,79	4,05	3,45	2,96
419,0	12,57	11,73	10,76	9,65	8,47	7,30	6,22	5,27	4,48	3,82	3,29
457,2	14,31	13,52	12,60	11,55	10,39	9,18	7,99	6,90	5,93	5,11	4,41
508,0	16,65	15,89	15,03	14,06	12,96	11,77	10,53	9,32	8,18	7,15	6,24
558,8	18,80	18,19	17,46	16,55	15,52	14,39	13,18	11,92	10,67	9,50	8,41
609,6	20,75	20,17	19,53	18,81	18,02	16,99	15,83	14,59	13,32	12,06	10,85

NOTE

Intermediate values may be obtained by interpolation but extrapolation is not permitted.

Table 2.6.2 Boom thrust coefficients (high tensile steel $\sigma_y = 355 \text{ N/mm}^2$)

Boom diameter, in mm	Boom length, in meters										
	6,0	7,5	9,0	10,5	12,0	13,5	15,0	16,5	18,0	19,5	21,0
152,4	1,56	1,01	0,72	—	—	—	—	—	—	—	—
159,0	1,80	1,15	0,82	—	—	—	—	—	—	—	—
165,1	2,04	1,30	0,92	—	—	—	—	—	—	—	—
168,3	2,17	1,39	0,98	0,73	—	—	—	—	—	—	—
177,8	2,61	1,67	1,15	0,87	—	—	—	—	—	—	—
193,7	3,45	2,24	1,54	1,12	0,88	—	—	—	—	—	—
219,1	5,05	3,40	2,35	1,70	1,28	1,02	—	—	—	—	—
244,5	6,88	4,86	3,42	2,48	1,87	1,45	1,16	—	—	—	—
267,0	8,60	6,39	4,61	3,37	2,53	1,97	1,57	1,28	—	—	—
273,0	9,07	6,83	4,96	3,64	2,74	2,12	1,69	1,38	—	—	—
298,5	11,05	8,77	6,13	4,94	3,74	2,90	2,31	1,87	1,55	—	—
323,9	13,00	10,79	8,47	6,48	4,97	3,87	3,08	2,49	2,06	1,73	1,47
355,6	15,41	13,35	10,98	8,70	6,82	5,37	4,28	3,47	2,86	2,39	2,03
368,0	16,34	14,34	11,99	9,65	7,63	6,04	4,83	3,92	3,23	2,70	2,29
406,4	18,96	17,39	15,16	12,73	10,41	8,42	6,83	5,58	4,61	3,85	3,26
419,0	19,73	18,28	16,20	13,77	11,39	9,29	7,57	6,21	5,14	4,30	3,64
457,2	22,03	20,71	19,07	16,99	14,51	12,15	10,09	8,38	6,99	5,87	4,98
508,0	25,04	23,85	22,40	20,64	18,64	16,31	13,93	11,81	10,00	8,49	7,25
558,8	28,02	26,92	25,61	24,04	22,20	20,16	18,08	15,73	13,56	11,68	10,07
609,6	30,97	29,95	28,74	27,32	25,64	23,74	21,68	19,59	17,55	15,35	13,40

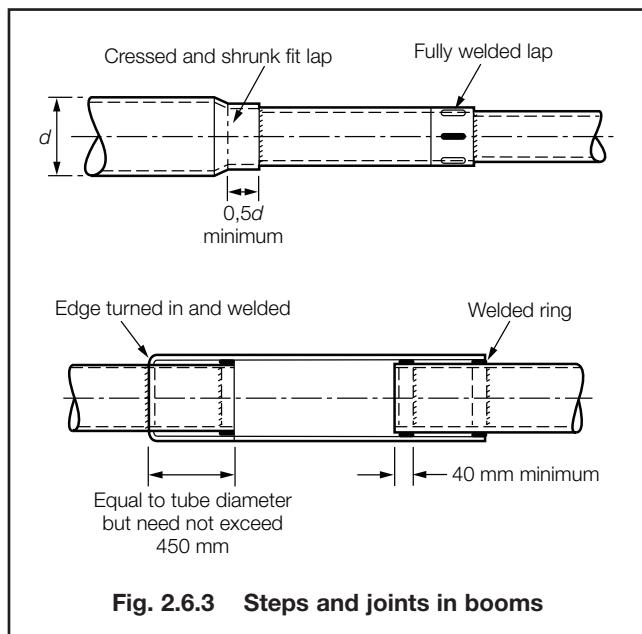
NOTE

Intermediate values may be obtained by interpolation but extrapolation is not permitted.

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6.4.6 Derrick boom crossheads, brackets for cargo runner and span tackle blocks and similar structures are to be of such a design that the combined stress does not exceed $0,56\sigma_y$.

SWL = the safe working load of each derrick operating simultaneously, in tonnes

Lever = the corresponding distance of the load on that derrick from the centreline of the ship, in metres

Displacement = the lightweight plus 50 per cent of the deadweight of the ship, in tonnes

GM = the transverse metacentric height of the ship in that condition, before lifting the load, in metres.

7.1.5 Direct calculation procedures may be accepted as an alternative to the methods indicated in this Section.

7.1.6 Special consideration on the general basis of these requirements will be given to the scantlings and arrangements where:

- (a) The mast is of portal, bipod, lattice or other less common design, or is supported by rigid stays capable of being loaded in compression.
- (b) Significant forces other than those resulting from cargo gear loads will be acting on the mast.

7.1.7 In such cases fully detailed stress calculations are to be submitted and these calculations are to take account of:

- (a) All horizontal, vertical and torsional forces.
- (b) Deflections of the structure.
- (c) Variations in the moment of inertia of the parts of the structure.
- (d) The effects of outriggers and similar structures.
- (e) Elasticity and sag in stays, where fitted.

7.1.8 A stayed mast is one that is supported wholly or partly by one or more stays. The term 'stay' includes shrouds, forestays, backstays and similar supports. Where a stayed mast is so designed that the stays are only required to be set up when loads exceeding a specified value are to be lifted, this fact is to be clearly indicated on:

- The plans submitted for approval.
- The cargo gear certificates.
- The cargo gear particulars book.
- The mast itself.

7.1.9 The length of the mast, l , is to be measured from the uppermost deck or supporting deckhouse through which it passes. Arrangements where a deckhouse is specifically designed to give no effective support to the mast in either the transverse or the longitudinal directions will be specially considered.

7.1.10 The minimum outside dimensions of the mast at the level of the supporting deck is to be not less than $\frac{l}{27}$. This

dimension is to be maintained up to the level of the gooseneck fitting where this is entirely supported by the mast.

■ Section 7

Masts and derrick posts

7.1 General

7.1.1 The scantlings of masts and derrick posts intended to support derrick booms and similar lifting appliances are to be determined from the highest combination of stresses expected to arise when the gear is used in its most severe operating condition. Materials are to comply with 1.5.2.

7.1.2 The requirements of this Section apply to stayed or unstayed single masts of conventional design. The term mast is used to include derrick post, king post or similar structure.

7.1.3 Calculations are to be made with the derrick booms at the operating position which results in the maximum stresses on the mast. For masts supporting derricks, angles of heel and trim of the ship in this condition of less than 5° and 2° respectively may be ignored. Where these angles are exceeded, and in all cases where the mast supports derrick cranes or derricks of special design the actual angles are to be taken into account in calculating the stresses in the mast.

7.1.4 The angle of heel, ψ , of the ship is to be calculated for the specified condition of loading using the applicable stability data or may be approximated from:

$$\psi = \frac{57,3 \times \Sigma (\text{SWL} \times \text{Lever})}{\text{Displacement} \times \text{GM}} \text{ degrees}$$

where

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7.1.11 Where the mast is fitted with stays the outside least dimension of the mast at a point midway between the supporting deck and the lowermost stay is to be not less than $\frac{l}{30}$, but consideration will be given to reduce dimensions

where it can be shown that no danger of crippling exists under service conditions of combined thrust, bending moment and torque.

7.1.12 The wall thickness of the mast is to be not less than the greatest of the applicable values determined from Table 2.7.1.

Table 2.7.1 Minimum thickness of mast plating

Item	Minimum thickness, in mm
Curved plates	$0,32 \frac{d\sqrt{\alpha}\sigma_y}{350 + 2 \times \text{SWL}}$ or $\frac{d\sqrt{\alpha}}{100}$ or 7,5
Flat plates	$0,32 \frac{b\sqrt{\alpha}\sigma_y}{220 + 2 \times \text{SWL}}$ or $\frac{b\sqrt{\alpha}}{60}$ or 7,5

NOTES

- Where:

SWL = the safe working load of the largest derrick operating on the mast, in tonnes

d = maximum outside diameter of the mast at the position under consideration, in mm. Where the mast is not circular, d is to be taken as the maximum diameter of the circle of which the plate forms a part

b = width of flat plate, in mm, but is to be taken as not less than 60 per cent of the width of the mast at that point measured parallel to the flat plate

α = the ratio $\frac{\text{actual total stress at that point}}{\text{maximum allowable stress}}$
- Where stiffeners are fitted, b may be taken as the mean spacing of stiffeners. The required scantlings of the stiffeners to resist instability under end loading will be considered.

7.2 Symbols

7.2.1 The symbols used throughout this Section are defined in 1.6.2.

7.3 Loading and allowable stresses

7.3.1 Calculations are to be made for the least favourable combinations of loading which may be imposed by the derrick systems. The following combinations are, generally, to be considered:

- Swinging derrick systems and derrick cranes:
 - For mast with one or two derricks.

One or both derricks plumbing one hatch.
One or both derricks slewed outboard on one side of the ship.
 - For mast with three or more derricks.

Two derricks plumbing one hatch.
Two derricks slewed outboard on one side of the ship.

- For mast with a heavy derrick fitted.
The heavy derrick plumbing the hatch.
The heavy derrick slewed outboard.

- Union purchase systems:

- One pair of derricks plumbing one hatch.
- One pair (or two pairs if fitted) of derricks with the load outboard on one side of the ship.

7.3.2 Where any other combination of operating derricks is proposed or where it is possible for the greatest stresses to arise at other positions of the derricks, the resultant loads are to be considered.

7.3.3 The effects of wind, ice and the normal motion of a ship in a seaway may, generally, be ignored in the calculations.

7.3.4 Where it is intended to operate the derrick system in a specified service category, see Ch 1.4, the resulting additional forces imposed on the system will be specially considered.

7.3.5 The maximum allowable combined bending and direct stress is not to exceed the value given in Table 2.7.2. The maximum allowable shear stress is not to exceed 0,58 times the value given in Table 2.7.2.

Table 2.7.2 Allowable stresses in masts

Item	Allowable stress, in N/mm ²
(1) Stayed mast:	
SWL ≤ 10 t	$0,50\sigma_y$
SWL ≥ 60 t	$0,625\sigma_y$
10 < SWL < 60 t	by interpolation
(2) Unstayed mast:	
SWL ≤ 10 t	$0,55\sigma_y$
SWL ≥ 60 t	$0,675\sigma_y$
10 < SWL < 60 t	by interpolation
(3) Cross trees, outriggers, etc.:	
SWL ≤ 10 t	$0,55\sigma_y$
SWL ≥ 60 t	$0,675\sigma_y$
10 < SWL < 60 t	by interpolation
(4) Mast under steady load	$0,625\sigma_y$
(5) Mast of controlled design with SWL ≥ 60 t	$0,83\sigma_y$

NOTES

- SWL for masts is to be taken as that of the largest derrick operating on the mast.
- SWL for cross trees, outriggers, etc., is to be taken as that of the largest derrick actually supported by the cross tree.
- Masts designed solely for the purpose of supporting conveyor belt arms, grain suction tubes and similar items are considered to be working under steady load.

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7.3.6 For masts of controlled design, where it is proposed to adopt the maximum stress value of $0.83\sigma_y$ permitted by item (5) of Table 2.7.2, the following requirements are to be met:

- (a) A detailed stress calculation is to be made.
- (b) All scantlings are to be based on the guaranteed minimum thickness of the materials used.
- (c) Full account is taken in the calculations of heel and trim of the self-weight of the gear, including guys.
- (d) The effect of any guy tension which could occur in operation is to be included.
- (e) Means are to be provided for controlling the tension in the stays, if fitted.
- (f) The mast, fittings and loose gear are to be manufactured to high engineering standards.

7.4 Stress calculations – Unstayed masts

7.4.1 The forces imposed on the mast by the cargo runner, span tackle and gooseneck are to be determined from the force diagrams or calculations prepared in accordance with Section 2. The resulting stresses in the mast are to be calculated taking into account the effect of any offsets in the lines of action of the forces.

7.4.2 The total stress (σ_t) at any particular location is to be taken as:

$$\sigma_t = [(\sigma_b + \sigma_c)^2 + 3q^2]^{1/2} \text{ N/mm}^2$$

where

- σ_b = the bending stress at that location due to the bending moments acting on the mast
- σ = the direct compressive stress at that location due to the vertical components of force. In general, the weight of the mast and cross trees may be ignored in this calculation
- q = the shear stress due to torque in the mast. The effect of torque need only be considered where cross trees are fitted.

7.4.3 The total stress is to be determined at each change of plate thickness or other change of section along the mast. It is recommended that a plot or table of stress to a base of mast length be prepared. At no point is σ_t to be greater than the allowable stress determined from 7.3.5.

7.5 Stress calculations – Stayed masts

7.5.1 Calculations are to be prepared for the conditions with the derrick operating parallel to the centreline of the ship and when slewed to the most outboard operating position. Other positions are to be examined where the arrangement of stays is such that higher stresses can be expected in the system.

7.5.2 The forces acting on the mast resulting from the cargo runner, span tackle and gooseneck are to be determined from the force diagrams or calculations prepared in accordance with Section 2. Where cross trees are fitted or where the vertical separation of the highest and lowest points of attachment of the mast head span cargo lead blocks and the stays exceed $0.1H$ m the calculations of forces will be specially considered. A fully detailed direct calculation may be required.

7.5.3 In the absence of stays the mast will deflect under the influence of the imposed forces. Where stays are fitted they will extend under tension, the amount of elongation being related to the deflection of the mast at the point of attachment of the stays.

7.5.4 The distribution of forces in the mast and stays may therefore be obtained by consideration of:

- (a) The equilibrium between the deflection of the mast and the corresponding elongations of the stays.
- (b) The equilibrium between the imposed loads on the mast and the reactions in the mast and the stays.

7.5.5 These calculations are to be made using appropriately defined co-ordinate axes. Attention is drawn to the importance of assigning the correct sign to the angles and dimensions used. Any stay which would be required to work in compression is to be ignored.

7.5.6 Elongation of the stays is to be calculated on the basis of the area enclosed by a circle of diameter equal to the nominal diameter of the rope in association with an effective modulus of elasticity of 61300 N/mm^2 (6250 kgf/mm^2). Consideration will, however, be given to the use of a higher modulus of elasticity where this is demonstrated by suitable tests to be applicable.

7.5.7 The total stress in the mast at any particular location is to be determined in accordance with 7.4.2 and 7.4.3. Attention is drawn to the fact that increased stiffness of the mast leads to a rapid increase in stress in the mast with a corresponding reduction in the effectiveness of the stays. It is desirable, therefore, to design the mast for the required section modulus in association with the least practicable moment of inertia.

7.6 Construction details

7.6.1 Masts are to be supported by at least two decks and are to be effectively scarfed into the main hull structure. The hull structure is to be suitably reinforced. A deckhouse may be considered as a support provided it is of adequate strength.

7.6.2 Alternative means of achieving efficient support for the mast will be considered. Where brackets are fitted to the deck at the mast heel they are to be of sufficient size to provide an adequate path for loads to be carried to the under-deck stiffening and surrounding structure.

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7.6.3 Where the lower part of the mast is integral with the deckhouse, the plating is to be increased in thickness and additional stiffening fitted to ensure adequate strength and resistance to plate buckling. Openings are, in general, to be avoided in these areas, but where required are to be well rounded and suitable edge stiffening is to be fitted.

7.6.4 In general, mast scantlings are not to be reduced inside deckhouses.

7.6.5 Cross trees, outriggers, brackets on bridge fronts and similar structures are to be of such design that the stresses on them resulting from the cargo gear and any other significant forces do not exceed the values in 7.3. The design is also to be such as to minimize the moments acting on the mast. Attachment to the mast is to be such as to avoid distortion of the mast under load. Local stiffening, doublers or diaphragm plates are to be fitted to the mast as necessary.

7.6.6 Special attention is to be paid to structural continuity and abrupt changes of section are to be avoided. Manholes, lightening holes and other cut outs are to be avoided in way of concentrated loads and areas of high shear. Where required, openings are to be well rounded, suitably framed and stiffened.

7.6.7 Adequate reinforcement is to be fitted in way of concentrated loads. The toes of brackets and corners of fittings are not to land on unstiffened panels of plating. Suitable arrangements are to be made to avoid notch effects.

7.6.8 Care is to be taken in the design of masts and fittings to reduce the likelihood of water collecting in inaccessible parts of the structure. Drains or other means are to be provided to remove any water which might otherwise accumulate. All parts are to be accessible for inspection and painting except where closed box construction is adopted.

7.6.9 Welding and weld details are to comply with the requirements of Pt 3, Ch 10 of the Rules for Ships.

7.6.10 Where a mast is intended to support a derrick with a SWL exceeding 25 t all welded joints below a distance of 3,0m above the uppermost supporting deck or to the level of the derrick heel if more than 3,0m, are to be examined by non-destructive crack or flaw detection methods.

7.6.11 Where higher tensile steel is used, preheating or other heat treatments may be required at the Surveyor's discretion and will, normally, be required for all ring seams on masts supporting derricks with a SWL exceeding 60 t. Non-destructive methods of examination may be required in areas of high stress in way of fittings at the Surveyor's discretion.

7.6.12 Lightning conductors are to be fitted to masts having wood, aluminium or plastic topmasts or where a break in electrical conductivity occurs in other arrangements.

7.7 Stays

7.7.1 Wire rope stays are to be in one length and their construction is to comply with the requirements of Chapter 6.

7.7.2 The scantlings of the stay are to be such as to provide the tensile force and elongation to meet the requirements of 7.5. The breaking load of the stay is to be not less than 3,5 times the maximum calculated force on that stay.

7.7.3 Stays are to be arranged so that they do not foul running rigging or derrick booms when in service and are to be set up with an initial tension of about 30,0 N/mm² (3,0 kgf/mm²).

7.7.4 The connection of the stay to a deck, bulwark, house or mast is to be such as to allow rotation at the point of attachment and is to be designed so that the stay cannot become disconnected while the derrick system is in use.

7.7.5 It is undesirable to connect stays to the ends of cross trees where deflection under load may significantly affect the load bearing efficiency of the stay.

■ Section 8

Fittings for masts and derrick booms

8.1 General

8.1.1 The application of fixed fittings, ropes and loose gear in derrick systems is to comply with the requirements of this Section. The items themselves are to be manufactured in accordance with the requirements given in Chapter 6.

8.1.2 Effective continuity of materials is to be maintained in the bearing brackets for fittings and abrupt changes of plate thickness are to be avoided. Care is to be taken to avoid pockets in which water may collect. The connection to the mast or derrick boom is to provide an easy transfer of load into the surrounding structure and to minimize hard spots and sources of stress concentration.

8.1.3 All welds are to be sound, uniform and free from undercutting or other defects. Care is to be taken to ensure adequate weld penetration. Effective arrangements are to be made for the inspection of finished welds. The extent of examination by non-destructive methods is to be to the Surveyor's satisfaction.

8.1.4 All bearing surfaces are to be machined to ensure a smooth finish and a good fit. Adequate and accessible means of lubrication are to be provided.

8.2 Goosenecks and derrick heel assemblies

8.2.1 The gooseneck bearing assembly is to be such that:

- The gooseneck pin is secured in position to prevent displacement under normal operating conditions.
- Brackets and supporting structure are adequate to support the forces from the derrick boom operating at the maximum and minimum angles. Edges of brackets are to be stiffened as necessary to resist distortion.
- Where the gooseneck is supported by a mast, a diaphragm or equivalent stiffening is fitted, or the width of brackets or other attachment is not less than two thirds of the diameter of the mast at that level.

8.2.2 Derrick heel fittings are to be such that:

- The axis of the derrick heel crosspin cuts the axis of the derrick boom. Design incorporating a small offset will be specially considered.
- The derrick heel crosspin is secured to prevent displacement under normal operating conditions.

8.2.3 Trunnions and other alternatives to goosenecks will be specially considered.

8.2.4 Adequate means are to be provided for the lubrication of all bearing surfaces and their protection from contamination by dirt or excessive water. Such protection is not to make inspection of the assembly unreasonably difficult.

8.3 Cargo runner and span tackle

8.3.1 The cargo runner is to be of sufficient length to ensure that, with the derrick rigged for lifting its maximum safe working load, at least two turns remain on the winch barrel when the derrick is at either:

- its highest working position and lifting from the tank top or lowest level from which it can be operated;
- its maximum overside position and lifting from a lighter with the ship at its light waterline.

The cargo runner is to be securely attached to the winch barrel.

8.3.2 The length of the span tackles is to be such that at least two turns remain on the winch barrel when the derrick is at its position of maximum outreach, or one turn when the derrick is in its stowed position. Where single rope spans are fitted the span rope may be led to a topping winch or be fitted with a span chain securely attached to the deck eyeplates by a shackle or screw pin. Where span chains are fitted, the links are to be of sufficient size that the eye of a shackle can be passed through. Where the span rope is more than one part, it is to be led to a winch barrel or topping winch and securely attached to it.

8.4 Slewing and preventer guys

8.4.1 In general, each derrick boom is to be provided with two slewing guys where the SWL of the derrick does not exceed 20 tonnes or three guys for derricks with higher safe working loads. The safe working load of each guy is to be not less than that required by Table 2.8.1. Where three guys are required deck fittings are to be provided so that two guys can be used on each side of the ship. For slewing guys used with derrick cranes, see 5.3.3.

Table 2.8.1 SWL of derrick boom slewing guys

SWL of derrick rig not exceeding, tonnes	SWL of each slewing guy, tonnes
1	1
2	1,5
3	2
4	2,5
5	3
6	3,25
9,5	3,5
12,5	3,75
15	4
60	25% of derrick SWL
75	15
over 75	20% of derrick SWL

8.4.2 Where the angle of heel or trim in the operating condition exceeds 5° or 2° respectively, the requirements for slewing guys will be considered.

8.4.3 Alternative arrangements of slewing guys and proposals for reduced slewing guys where cargo slewing guys are fitted will be specially considered. Such arrangements are to be capable of operating at 5° heel and 2° trim or greater angles where specified.

8.4.4 Natural or man-made fibre ropes may be used in the guy tackle (but not the guy pendant) provided the SWL of the guy does not exceed 4 t.

8.4.5 Where derricks are rigged for use in union purchase, preventer guys are to be fitted in addition to slewing guys. Preventer guys are to have a safe working load not less than the maximum guy tension derived from 4.3. Fibre rope is not to be used for preventer guys.

8.4.6 Boom head or schooner guys used for cross-connecting the heads of derricks in union purchase are to have a safe working load not less than 20 per cent of the SWL of the union purchase system, but not less than 1,0 t. These guys may be of steel wire or of fibre rope.

8.4.7 The hauling end of wire rope slewing guys is to be securely attached to a winch barrel when the derrick is being slewed under load.

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8.4.8 Slewing guys are to be attached to the derrick boom and the deck eyeplate by a link, shackle or similar device so designed as to permit the guy to take up its varying positions while maintaining a straight lead. Leads are to be such that the guys will not foul rails, bulwarks or other obstructions when under load. Fairleads may be used.

8.4.9 Preventer guys are to be shackled on, or looped over the derrick head and shackled, or equivalent, to eyeplates on the deck or bulwark.

8.5 Swivelling and fixed eyeplates

8.5.1 Swivelling eyeplates are to be used for the attachment of span tackle and cargo runner lead blocks to the mast for all derricks where the safe working load is 3,0 t or more or where the load in the span tackle exceeds 5,0 t. They may also be used elsewhere.

8.5.2 Fixed eyeplates at the derrick head may be of the 'sword-fitting' type, providing a pair of eyeplates on opposite sides of the derrick tube, or the fitting may penetrate one side of the tube and be securely attached to internal structure.

8.6 Blocks

8.6.1 Swivels are to be arranged as necessary to ensure that blocks maintain their correct alignment.

8.6.2 The cargo runner lead block at the derrick heel is to have a duckbill or similar head fitting which prevents the block falling when the cargo runner is slack. This is to be arranged so as to allow the heel block to clear the derrick tube when the derrick tube is in its stowed position.

8.6.3 Snatch blocks may only be used as deck lead blocks.

8.6.4 Wood blocks may only be used with fibre ropes.

8.7 Cargo hooks

8.7.1 Cargo hooks are to be of such construction or shape, or are to be provided with an efficient device, so as to prevent displacement of the sling or load from the hook.

8.7.2 In general, 'C', (or Liverpool) type hooks may be used where the SWL of the derrick rig does not exceed 25 t. Cargo hooks of the Ramshorn type may be used in rigs of any SWL. Proposals to use other designs of hook will be considered.

8.8 Miscellaneous fittings

8.8.1 Where built-in sheaves are fitted to the derrick boom the design of the sheave slot is to be such as to maintain continuity of strength of the boom tube. A typical arrangement is shown in Fig. 2.8.1 but alternative arrangements will be considered.

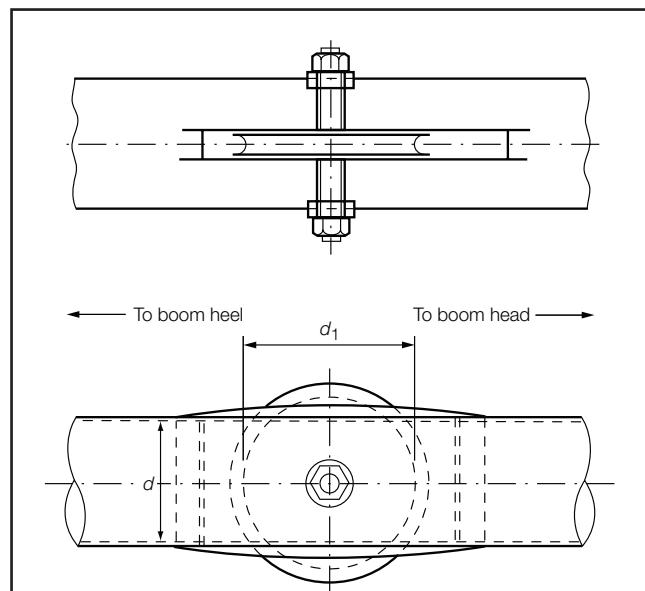


Fig. 2.8.1 Built-in sheaves

8.8.2 Where cargo runner roller guides are fitted to the derrick boom, they are to be such that:

- (a) They are of adequate strength to resist distortion.
- (b) Any tendency for the runner to chafe or jam in or between the rollers and their supports is minimized.
- (c) There is adequate means of lubrication.

8.8.3 Where it is intended to loop preventer guys over the end of a derrick boom, a preventer safety catch is to be securely welded or otherwise fixed to the boom. This safety catch can take the form of the boom end sealing plate being extended, over part of its circumference, beyond the outer surface of the boom tube, or alternatively a separate fitting can be used. Edges are to be smoothed.

8.9 Deck eyeplates

8.9.1 Sufficient eyeplates or equivalent attachments are to be provided for the safe operation of the derrick system and they are to be of suitable design and safe working load.

8.9.2 Eyeplates are not to be welded to the upper edge of the sheerstrake nor, in general, are they to penetrate the strength deck plating. Deck, bulwark or other plating is to be of sufficient thickness to withstand any shear forces that may be incurred in way of eyeplates due to asymmetrical loading of the eyeplate, and such plating is to be stiffened as necessary to prevent deformation under direct eyeplate loadings. The attachment of eyeplates and the adequacy of the supporting structure is to be to the Surveyor's satisfaction.

Section

- 1 **Introduction**
- 2 **Shipboard cranes**
- 3 **Offshore cranes**
- 4 **Submersible handling systems**
- 5 **Pedestals and foundation**

■ **Section 1**
Introduction

1.1 General

1.1.1 This Chapter is applicable to the crane types as generally indicated in 1.2.1. In addition it covers all types of diving and submersible handling systems both manned and unmanned.

1.1.2 Derrick cranes are not covered by this Chapter but are to be designed in accordance with the requirements of Chapter 2.

1.2 Crane types

1.2.1 This Chapter will be the basis of approval by Lloyd's Register (hereinafter referred to as LR) of the following types of crane or lifting appliance:

- (a) Deck cranes mounted on ships for handling equipment or cargo in harbour conditions.
- (b) Container handling cranes mounted on ships for handling containers or cargo in harbour conditions.
- (c) Floating cranes mounted on barges or pontoons for handling loads in harbour conditions.
- (d) Grab cranes mounted on ships, barges or pontoons for operating in harbour conditions.
- (e) Engine room, stores cranes, etc., mounted on ships for handling equipment and stores in harbour conditions.
- (f) Cranes mounted on fixed or mobile offshore installations for transferring equipment, stores, etc., to and from supply ships.
- (g) Cranes mounted on ships for handling non-manned equipment in an offshore environment, e.g., pipe laying cranes.
- (h) Installations mounted on fixed or mobile offshore installations for handling manned submersibles and diving systems.

1.2.2 Any crane or lifting appliance not covered by the description or environmental conditions above will be specially considered.

1.3 Service category

1.3.1 The service category as defined in Chapter 1 must be clearly stated on all submissions together with all relevant design criteria.

1.3.2 It is anticipated that shipboard cranes will generally fall into standard service category whereas offshore cranes and submersibles handling systems will inevitably come into the specified service category.

1.3.3 In the case of offshore cranes the rating for the standard and specified service category, which, in general, will comprise load v. radius diagrams for various sea state conditions, are to be submitted for approval. Approval on the basis of standard service category only, will not be permitted for cranes on offshore installations except where the crane is to be used solely for lifting operations on the installation itself.

1.3.4 The service category applicable to the particular appliance will also apply to the supporting pedestal and foundations.

1.4 Alternative basis of approval

1.4.1 A recognized national standard will be considered as an alternative basis for approval of cranes provided LR is satisfied that the criteria are at least equivalent to the design criteria specified in this Chapter for the applicable service category.

■ **Section 2**
Shipboard cranes

2.1 General

2.1.1 This Section applies to shipboard cranes, generally described in 1.2.1(a) to (e), which are designed to operate in a harbour or sheltered water environment where there is no significant movement of the ship due to wave action and the sea state is not worse than that described for Beaufort No. 2.

2.1.2 The forces and loads acting on the crane structure are to be determined in accordance with the operating and environmental conditions for which the crane is to be certified and must be clearly specified on all crane submissions together with the speeds of all crane movements, braking times, lifting capacities, ranges, etc.

2.2 Load considerations

2.2.1 Consideration is to be given to the utilization and duty of the particular type of crane in the 'in service' condition with respect to the following forces and loads:

- (a) Dead loads.
- (b) Live loads.
- (c) Dynamic forces due to the various crane movements.
- (d) Forces due to ship inclination.
- (e) Load swing caused by non-vertical lift.
- (f) Wind forces and environmental effects.
- (g) Loads on access ways, platforms, etc.
- (h) Snow and ice when considered relevant.

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2.2.2 The crane structure and any stowed arrangements are also to be examined with respect to the stowage condition for the following criteria:

- (a) Forces due to the ship motion and inclination.
- (b) Wind and environmental effects.
- (c) Snow and ice.

2.3 Duty factor

2.3.1 Cranes are grouped depending on the nature of the duty they perform and each group is designated a duty factor as given in Table 3.2.1.

Table 3.2.1 Duty factor, F_d

Crane types and use	Duty factor
Stores cranes	
Maintenance cranes	1,0
Engine room cranes	
Deck jib cranes	
Container cranes	1,05
Gantry crane	
Floating cranes	
Grab cranes	1,20

2.3.2 The duty factor, F_d , depends on the frequency of operation and the severity of the load lifted with respect to the appropriate safe working load of the crane concerned and is used to factor both the live and dead load components of loading. The factor assumes normal marine use, operating life not in excess of 6×10^5 cycles, and consideration is to be given to increasing these values where extra heavy duty is envisaged.

2.3.3 Where appropriate, fatigue calculations are to be carried out in accordance with a recognized national standard using stress cycles and load spectrum agreed between the manufacturer and the Owner.

2.4 Basic loads

2.4.1 The basic loads applied to the crane comprise the dead load, L_g , and the live load, L_l , which are as defined in Chapter 1.

2.5 Dynamic forces

2.5.1 The dynamic forces due to hoisting are those imposed on the structure by shock and accelerating the live load from rest to a steady hoisting speed. To take this effect into account in the design the live load is multiplied by a hoisting factor, F_h .

2.5.2 The hoisting factor is given by:

$$F_h = 1 + C_1 V_h$$

where

V_h = hoisting speed, in m/s but need be taken as not greater than 1,0 m/s

C_1 = a coefficient depending on the stiffness of the crane concerned

$C_1 = 0,3$ for jib type cranes, and
 $0,6$ for gantry type cranes.

A value of F_h is to be taken as not less than 1,10 for jib cranes and 1,15 for gantry cranes.

For grab duty F_h is to be multiplied by 1,05.

Values of F_h plotted against hoisting speed, V_h , are given in Fig. 3.2.1.

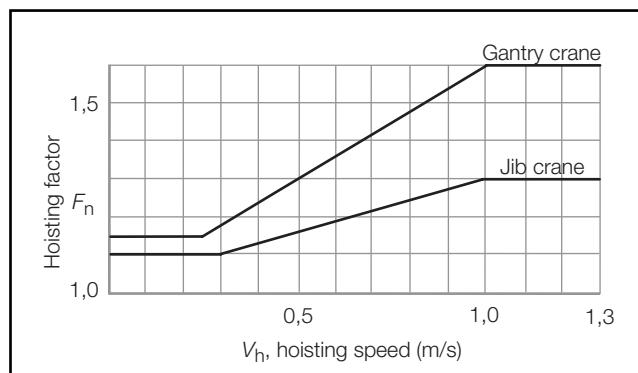


Fig. 3.2.1 Values of hoisting factor, F_h

2.6 Dynamic forces due to crane movements

2.6.1 Consideration is to be given to the forces which occur when a crane travels along a track or rails resulting in a vertical acceleration acting on the crane and its load together with the horizontal acceleration due to the crane changing speed whilst travelling.

2.6.2 The vertical acceleration is usually small provided the rail and joints are level and smooth and since it may be considered that it does not occur at the same time as the maximum dynamic force due to hoisting, it can generally be neglected.

2.6.3 The horizontal acceleration including that due to braking is to be supplied by the manufacturer. Where the acceleration is not available but speed and working conditions are known the acceleration is to be obtained from the following formulae:

- (a) For cranes with low travel speed (0,4 – 1,5 m/s)

$$f = 0,075V_h + 0,07.$$

- (b) For cranes with moderate to high travel speed (1,5 – 4,0 m/s), and normal acceleration

$$f = 0,075V_h + 0,20.$$

- (c) For cranes with travel speed of 1,5 – 4,0 m/s and high acceleration (0,4 – 0,7 m/s²)

$$f = 0,10V_h + 0,27.$$

where

$$f = \text{acceleration, in m/s}^2$$

and

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2.11.4 Alternatively where the crane is to be fitted to a conventional ship and the ship's characteristics are known, the forces may be calculated using accelerations obtained from consideration of the ship's motions given in Table 3.2.2, together with the force due to a wind speed of 63 m/s acting in the most unfavourable direction.

Table 3.2.2 Ship motions

Motion	Maximum single amplitude	Period in seconds
Roll	$\phi = 30^\circ$	$T_r = \frac{0,7B}{\sqrt{GM}}$
Pitch	$\psi = 12e^{-300}$	$T_p = 0,5\sqrt{L_{pp}}$
Heave	$\frac{L_{pp}}{80}$ m	$T_h = 0,5\sqrt{L_{pp}}$

where

L_{pp} = length of ship between perpendiculars, in metres
 B = moulded breadth of ship, in metres
 GM = transverse metacentric height of loaded ship, in metres
 ψ = is to be taken as not greater than 8° .

2.11.5 The forces due to ship motions are to be determined in accordance with Table 3.2.3.

2.11.6 The following combinations of static and dynamic forces are to be considered:

- (a) Rolling motion only:
Static roll + dynamic roll + dynamic heave (at roll angle ϕ).
- (b) Pitching motion only:
Static pitch + dynamic pitch + dynamic heave (at pitch angle ψ).
- (c) Combined motion:
Static combined +0,8 (dynamic roll + dynamic pitch).

In each case the component of force due to wind is to be included where applicable.

2.11.7 Proposals to use other values are to be substantiated by calculations and will be subject to special consideration.

Table 3.2.3 Forces due to ship motions

Source	Component of force, in newtons		
	Normal to deck	Parallel to deck	
		transverse	longitudinal
STATIC			
Roll	$W \cos \phi$	$W \sin \phi$	
Pitch	$W \cos \psi$	$W \sin (0,71\phi)$	$W \sin \psi$
Combined	$W \cos (0,71\phi) \cos (0,71\psi)$		$W \sin (0,71\psi)$
DYNAMIC			
Roll	$0,07024W \frac{\phi}{T_r^2} y$	$0,07024W \frac{\phi}{T_r^2} z_t$	
Pitch	$0,07024W \frac{\psi}{T_p^2} x$		$0,07024W \frac{\psi}{T_p^2} z_p$
Heave:			
Roll	$0,05W \frac{L_{pp}}{T_h^2} \cos \phi$	$0,05W \frac{L_{pp}}{T_h^2} \sin \phi$	
Pitch	$0,05W \frac{L_{pp}}{T_h^2} \cos \psi$		$0,05W \frac{L_{pp}}{T_h^2} \sin \psi$

Symbols

y = transverse distance parallel to deck from G of ship to G of crane, in metres
 x = longitudinal distance parallel to deck from centre of pitching motion, taken to be at longitudinal centre of flotation, to G of crane, in metres
 z_t = distance normal to deck from centre of rolling motion, taken to be at the vertical centre of gravity of the ship, to the vertical centre of gravity of the crane, in metres
 z_p = distance normal to deck from centre of pitching motion to centre of gravity of crane, in metres
 W = weight of crane or its component part, in newtons
 ϕ and ψ are in degrees

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2.12 Wind loading

2.12.1 The wind pressure, p , acting on the structure is given by the following formula:

$$p = 0,613V^2$$

where

p = pressure, in N/m^2

V = wind speed, in m/s

The wind speed for the operating condition is to be taken as 20 m/s and for the stowed condition as 63 m/s .

2.12.2 Where it is anticipated that wind speeds in excess of those defined above may occur, then these higher wind speeds are to be considered.

2.12.3 The wind force acting on the suspended load is to be taken as 300 N per tonne of SWL but where a crane is to be designed to handle loads of a specific shape and size the wind force may be calculated for the appropriate dimensions and configuration.

2.12.4 The wind force on the crane structure or individual members of the structure is to be calculated from the following expression:

$$F_w = A p C_f$$

where

A = the effective area of the structure concerned, i.e. the solid area projected on to a plane perpendicular to the wind direction, in m^2

p = wind pressure, in N/m^2

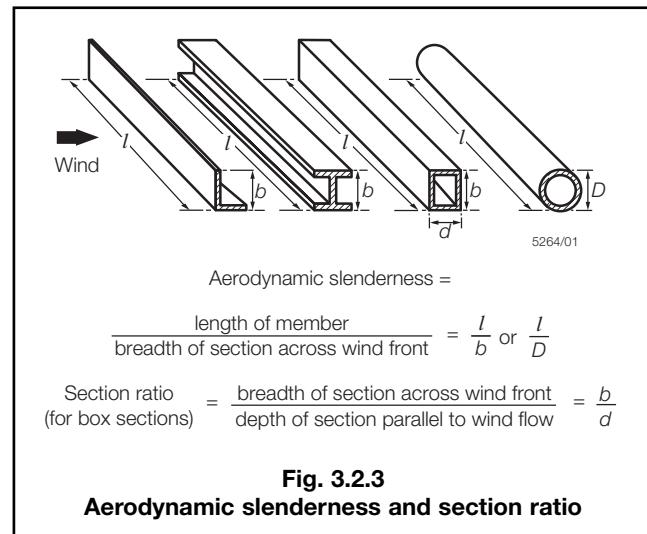
C_f = force coefficient in the direction of the wind

F_w = force due to the wind, in newtons.

2.12.5 The force coefficient for various structural components is given in Table 3.2.4. The values for individual members vary according to the aerodynamic slenderness and in the case of large box sections, with the section ratio. The aerodynamic slenderness and section ratio are given in Fig. 3.2.3.

Table 3.2.4 Force coefficient (C_f)

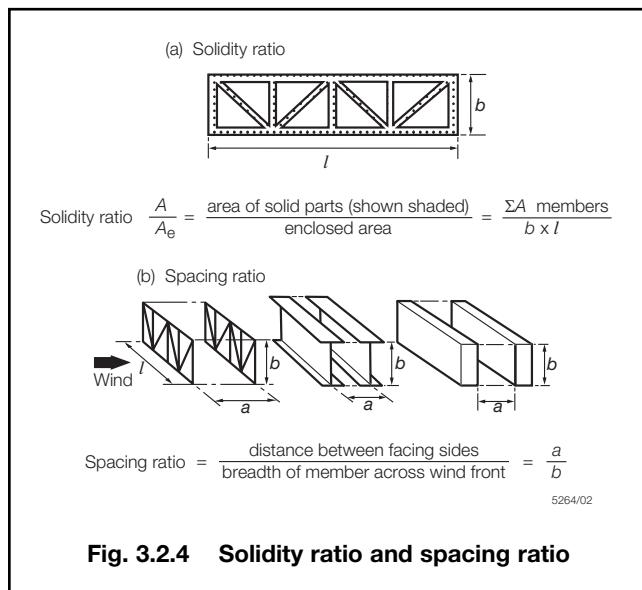
Type	Description	Aerodynamic slenderness I/b or I/D					
		5	10	20	30	40	50
Individual members	Rolled sections, rectangles, hollow sections, flat plates, box sections with b or d less than 0,5 m	1,30	1,35	1,60	1,65	1,70	1,80
	Circular sections, where $DV_s < 6 \text{ m}^2/\text{s}$ $DV_s \geq 6 \text{ m}^2/\text{s}$	0,75 0,60	0,80 0,65	0,90 0,70	0,95 0,70	1,00 0,75	1,10 0,80
	Box sections with b or d greater than 0,5 m	b/d $\geq 2,00$ 1,00 0,50 0,25	1,55 1,40 1,00 0,80	1,75 1,55 1,20 0,90	1,95 1,75 1,30 0,90	2,10 1,85 1,35 1,00	2,20 1,90 1,40 1,00
Single lattice frames	Flat sided sections					1,70	
	Circular sections, where $DV_s < 6 \text{ m}^2/\text{s}$ $DV_s \geq 6 \text{ m}^2/\text{s}$					1,20 0,80	
Machinery houses, etc.	Rectangular clad structures on ground or solid base (air flow beneath structure prevented)					1,10	



2.12.6 Where a structure consists of a framework of members such that shielding takes place, the wind force on the windward frame or member and on the sheltered parts of those behind it are calculated using the appropriate force coefficient. The force coefficient on the sheltered parts are to be multiplied by a shielding factor η . The values of η vary with the solidity and spacing ratio of the framework. Values of η are given in Table 3.2.5 for the solidity and spacing ratio as defined in Fig. 3.2.4.

Table 3.2.5 Shielding factor (η)

Spacing ratio a/b	Solidity ratio A/A_e					
	0,1	0,2	0,3	0,4	0,5	0,6
0,5	0,75	0,4	0,32	0,21	0,15	0,1
1,0	0,92	0,75	0,59	0,43	0,25	0,1
2,0	0,95	0,8	0,63	0,5	0,33	0,2
4,0	1	0,88	0,75	0,66	0,55	0,45
5,0	1	0,95	0,88	0,81	0,75	0,68
6,0	1	1	1	1	1	1

**Fig. 3.2.4 Solidity ratio and spacing ratio**

2.12.7 Where a structure consists of a number of identical frames or members spaced equidistantly behind each other in such a way that each frame shields those behind it the wind load is to be obtained from the following expression:

$$F = A p C_f \left(\frac{1 - \eta^n}{1 - \eta} \right)$$

where

- η = shielding factor from Table 3.2.5, but to be taken as not less than 0,1
- n = number of frames, but to be taken as not greater than 9.

2.12.8 For latticed tower structures, the 'face on' wind force based on the solid area of the windward face is to be multiplied by the following coefficients:

- (a) For towers composed of flat-sided sections
= $1,7p(1 + \eta)$
- (b) For towers composed of circular sections
where $DV_s < 6,0 \text{ m}^2/\text{s} = 1,2p(1 + \eta)$
and $DV_s \geq 6,0 \text{ m}^2/\text{s} = 1,4p(1 + \eta)$

where

D = the diameter of the section, in metres

V_s = the design wind speed, in m/s.

The value of η is taken from Table 3.2.5 for $a/b = 1,0$ according to the solidity ratio of the windward face.

2.12.9 The maximum wind load on a square section tower occurs when the wind blows onto a corner and is to be taken as 1,2 times the 'face on' load.

2.13 Snow and ice loads

2.13.1 In general, the effects of snow and ice loads acting on the crane structure may be neglected, although they should be considered where a particular design or application indicates that these loads are significant.

2.14 Temperature effects

2.14.1 In general, temperature effects need only be considered with respect to the selection of the steels used in the construction of the crane, see 2.26.

2.15 Platform and access way loading

2.15.1 Platforms and access-ways are to be designed to carry a uniformly distributed load over the full platform area of 5000 N/m^2 and a concentrated load of 3000 N on any individual member.

2.16 Load combinations

2.16.1 The crane design is to be considered with respect to loads resulting from the following conditions:

- Case 1 Crane operating without wind.
- Case 2 Crane operating with wind.
- Case 3 Crane in stowed condition.
- Case 4 Crane subjected to exceptional loading.

2.16.2 **Case 1.** For the condition of the crane operating without wind the design is to be considered with respect to a combination of dead load, live load and horizontal forces defined in 2.6 to 2.11, as given by the following expression:

$$F_d [L_g + F_h (L_1 + L_{h1}) + L_{h2} + L_{h3}]$$

where

F_d = duty factor

L_g = dead load, in newtons

L_1 = live load, in newtons

F_h = hoisting factor

L_{h1} = the horizontal component of live load due to heel and trim

L_{h2} = the next most unfavourable horizontal load (usually due to slewing acceleration)

L_{h3} = the horizontal component of dead load due to heel and trim.

2.16.3 **Case 2.** For the condition of the crane operating with wind the design is to be considered with respect to a combination of dead load, live load and horizontal forces defined in 2.6 to 2.11, together with the most unfavourable wind load. This is given by the following expression:

$$F_d [L_g + F_h (L_1 + L_{h1}) + L_{h2} + L_{h3}] + L_w$$

where

L_w = the most unfavourable wind load.

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2.16.4 **Case 3.** The crane is to be considered in its stowed condition when subjected to forces resulting from accelerations due to the ship's motions and static inclination together with wind forces appropriate to the stowed condition. The effects of anchorages, locks and lashings, etc., are to be taken into consideration.

2.16.5 **Case 4.** The crane may also need to be considered with respect to the following exceptional load conditions:

- (a) Coming into contact with buffers.
- (b) Failure of the hoist wire or sudden release of load for cranes with counterweight.
- (c) Test loading.

2.17 Stability

2.17.1 Travelling cranes, trolleys, grabs, etc., which are capable of travelling whilst loaded are to be examined with regard to stability against overturning for the following conditions:

- (a) The worst operating condition as given by load combination, Case 2, including forces resulting from an acceleration at deck level of 0,67 m/s² or maximum acceleration if known.
- (b) Consideration of sudden release of load in accordance with load combination, Case 2, with the hoisting factor, F_h , taken as -0,2.

2.17.2 The overturning moment is to be not greater than 80 per cent of the stabilizing moment.

2.17.3 Travelling cranes, etc., are to be provided with stowage locks or lashings or other means of resisting forces resulting from consideration of load combination, Case 3.

2.17.4 Devices used for anchoring the crane or trolley to its track or rails may be taken into account in calculating the stability of travelling cranes only if:

- (a) Such cranes or trolleys do not travel when loaded.
- (b) The design of the rail and its anchoring devices are such that stability is achieved by use of efficient wheels and properly designed rails. Alternative devices will be considered.

2.17.5 Consideration is to be given to the following aspects of crane stability:

- (a) Travelling cranes are to be provided with efficient stops at both limits of travel and are to be designed such that the crane will remain stable after contact with the stops under the most severe operating conditions.
- (b) Travelling cranes are to be designed to prevent complete derailment or loss of stability in the event of a wheel or axle failure or sudden release of load.

2.17.6 Jib cranes are to be designed with regard to the loading requirements of 2.16, such that the jib does not 'jack-knife' under operational and test loads. Alternatively, suitable stops may be fitted to prevent the jib from 'jack-knifing'.

2.18 Allowable stress – Elastic failure

2.18.1 The allowable stress, σ_a is to be taken as the failure stress of the component concerned multiplied by a stress factor, F , which depends on the load case considered. The allowable stress is given by the general expression:

$$\sigma_a = F\sigma$$

where

$$\begin{aligned}\sigma_a &= \text{allowable stress, in N/mm}^2 \\ F &= \text{stress factor} \\ \sigma &= \text{failure stress, in N/mm}^2.\end{aligned}$$

2.18.2 The stress factor, F , for steels in which $\frac{\sigma_y}{\sigma_u} \leq 0,7$

where

$$\sigma_y = \text{yield stress of material, in N/mm}^2$$

σ_u = ultimate tensile stress of the material, in N/mm² are given in Table 3.2.6.

Table 3.2.6 Stress factor, F

Load case	1	2	3 and 4
Stress factor, F	0,67	0,75	0,85

2.18.3 For steel with $\frac{\sigma_y}{\sigma_u} > 0,7$ the allowable stress is to be

derived from the following expression:

$$\sigma_a = 0,41F(\sigma_u + \sigma_y)$$

$$\tau_a = 0,24F(\sigma_u + \sigma_y)$$

where

$$\tau_a = \text{allowable shear stress.}$$

2.18.4 The failure stress for the elastic modes of failure are given in Table 3.2.7.

Table 3.2.7 Failure stress

Mode of failure	Symbol	Failure stress
Tension	σ_t	$1,0\sigma_y$
Compression	σ_c	$1,0\sigma_y$
Shear	τ	$0,58\sigma_y$
Bearing	σ_{br}	$1,0\sigma_y$

2.18.5 For components subjected to combined stresses the following allowable stress criteria are to be used:

$$(a) \sigma_{xx} < F\sigma_t$$

$$(b) \sigma_{yy} < F\sigma_t$$

$$(c) \tau_o < F\tau$$

$$(d) \sigma = (\sigma_{xx}^2 + \sigma_{yy}^2 - \sigma_{xx}\sigma_{yy} + 3\tau_o^2)^{1/2} \leq 1,1F\sigma_t$$

where

$$\sigma_{xx} = \text{applied stress in x direction, in N/mm}^2$$

$$\sigma_{yy} = \text{applied stress in y direction, in N/mm}^2$$

$$\tau_o = \text{applied shear stress, in N/mm}^2.$$

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2.19 Allowable stress – Compression and bending members

2.19.1 The allowable stress for compression members is to be taken as the critical compressive stress, σ_{cr} multiplied by the allowable stress factor, F , as defined in Table 3.2.6. In addition to local failure due to the critical compression stress being exceeded consideration is to be given to the overall ability of crane jibs to resist compression loading, see 2.20.

2.19.2 For members subjected to simple compression the critical compression stress is given by the Perry-Robertson formulae as a function of the slenderness ratio of the member, s , Robertson's coefficient, a , as given in Table 3.2.9, and the yield stress of the material, σ_y . Values of critical compression stress are given in Table 3.2.10. Linear interpolation may be used for intermediate values of slenderness ratio.

2.19.3 The values of Robertson's coefficient are given in Table 3.2.9. The slenderness ratio for members with constant radius of gyration is obtained from the following formulae:

$$s = \frac{KL}{r}$$

where

s = slenderness ratio

L = length of member, in mm

r = radius of gyration of member, in mm

K = a constant which depends on the end constraint conditions of the member and is obtained from Table 3.2.8.

For members with varying radius of gyration an effective radius of gyration is to be calculated in accordance with 2.20.

Table 3.2.8 Value K , for different constraint conditions

Diagrammatic representation	Restraint conditions	K
	Constrained against rotation and translation at both ends	0,7
	Constrained against rotation and translation at one end and translation only at other end	0,85
	Constrained against translation only at each end	1,0
	Constrained against rotation and translation at one end and against rotation only at other end	1,5
	Constrained against rotation and translation at one end and free to rotate and translate at other end	2,0

2.19.4 For members subjected to combined bending and compression the following stress criteria is to be used:

$$\frac{\sigma_b}{\sigma_t} + \frac{\sigma_c}{\sigma_{cr}} < F$$

where

σ_b = applied bending stress, in N/mm²

σ_c = applied compression stress, in N/mm².

2.20 Crane jibs – Overall stability

2.20.1 In addition to individual members of the jib structure being examined with respect to buckling, crane jibs are to be considered with respect to critical compressive failure of the jib as a whole with regard to both plan and elevation planes.

2.20.2 The slenderness ratio is the effective length of the jib divided by the radius of gyration in the plane concerned. To allow for the variation in radius of gyration with length an effective radius of gyration is to be calculated in accordance with 2.21.

2.20.3 The effective length of the jib is dependent on the constraint conditions at its ends. The conditions are different in plan view to those in elevation and are also dependent on the type of jib concerned of which there are two types, rope supported and cantilever jibs.

2.20.4 For rope supported jibs the effective length is to be calculated in the following manner:

- In elevation, the jib can be considered as being fixed against translation and free to rotate so that the effective length is taken as the actual length of the jib for all jib attitudes, i.e. $K = 1,0$.
- In plan the lower end of the jib is to be considered as fixed against translation and rotation by the jib pivots and the head is to be considered as partially constrained with respect to translation by the hoist and luffing ropes, the constraint varying with the tension in these ropes and attitude of the jib. The effective length in plan view is given by

$$l = LK$$

where

l = effective length, in mm

L = the actual length of the jib, in mm

$$K = \text{a constant equal to } 2 - \left[\frac{R(D + CH)}{R_H D + C R_S H} \right]$$

where

C is the ratio of load applied to the jib head by the luffing rope to that applied to the non vertical part of the hoist rope,

and R , R_H , R_S , D and H are dimensions, in mm, as shown in Fig. 3.2.5.

2.20.5 The above method is considered satisfactory for conventional jibs, but jibs of slender design or very high strength steel construction are to be analysed taking into account second and higher order effects due to deflection of the structure by iterative or other suitable methods, and calculations submitted.

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Table 3.2.9 Values of Robertson Constant, a , for various sections

Type of section	Thickness of flange or plate, in mm	Axis of buckling	a
Rolled I section (universal beams)		xx yy	2,0 3,5
Rolled H section (universal columns) See Note 1	up to 40 over 40	xx yy xx yy	3,5 5,5 5,5 8,0
Welded plate I or H sections See Notes 1, 2 and 3	up to 40 over 40	xx yy xx yy	3,5 5,5 3,5 8,0
Rolled I or H section with welded flange cover plates See Notes 1 and 4	'	xx yy xx yy	3,5 2,0
Welded box sections See Notes 1, 3 and 4	up to 40 over 40	any any	3,5 5,5
Rolled channel sections, rolled angle sections and T-bars (rolled or cut from universal beam or column)		any	5,5
Hot-rolled structural hollow sections		any	2,0
Rounds, square and flat bars See Note 1	up to 40 over 40	any any	3,5 5,5
Compound rolled sections (2 or more I, H or channel sections, I section plus channel, etc.)		any	5,5
Two rolled angle, channel or T-sections, back-to-back		any	5,5
Two rolled sections laced or battened		any	5,5
Lattice strut		any	2,0

NOTES

- For thicknesses between 40 mm and 50 mm the value of σ_{cr} may be taken as the average of the value for thicknesses less than 40 mm and the value for thicknesses greater than 40 mm.
- For welded plate I or H sections where it can be guaranteed that the edges of the flanges will only be flame-cut, $a = 3,5$ may be used for buckling about the y-y axis for flanges up to 40 mm thick and, $a = 5,5$ for flanges over 40 mm thick.
- Yield strength for sections fabricated from plate by welding reduced by 25 N/mm².
- 'Welded box sections' includes those fabricated from four plates, two angles or an I or H section and two plates but not box sections composed of two channels or plates with welded longitudinal stiffeners.

2.21 Slenderness ratio

2.21.1 The slenderness ratio of compression members is given by the general expression in 2.19.3, i.e.

$$s = \frac{Kl}{r} \text{. For members which have constant area and}$$

uniformly varying second moment of area and hence radius of gyration, such as crane jibs, an effective radius of gyration is to be considered. The effective radius of gyration is given by:

$$r_e = \left(\frac{I_e}{A} \right)^{1/2}$$

where

r_e = effective radius of gyration, in mm

I_e = $m I_2$, in mm⁴

A = cross sectional area, in mm²

where

I_2 = maximum second moment of area of member in the plane concerned and m is obtained from Tables 3.2.11 to 3.2.13 inclusive as appropriate.

Table 3.2.10 Values of σ_{cr} for steel for varying σ_y

Yield stress, in N/mm ²	240				260				360				
	Robertson's constant, a	2,0	3,5	5,5	8,0	2,0	3,5	5,5	8,0	2,0	3,5	5,5	8,0
Slenderness ratio, s													
20	239	239	238	237	259	258	257	255	356	353	350	345	
30	234	230	224	218	253	248	242	234	348	339	328	316	
40	228	220	210	199	246	237	226	214	337	322	305	286	
50	221	201	195	181	238	225	210	194	323	301	278	256	
60	212	196	180	163	228	210	192	174	302	275	249	225	
70	200	182	163	146	214	193	174	156	272	245	219	196	
80	185	165	147	131	196	175	155	138	237	213	190	170	
90	167	148	131	116	175	156	138	122	202	182	164	147	
100	149	132	117	103	154	137	122	108	171	156	141	127	
110	131	117	103	92	134	121	107	96	146	134	122	111	
120	115	103	92	82	117	106	95	85	125	116	106	97	
130	101	91	82	73	102	93	84	76	108	101	93	85	
140	89	81	73	66	90	83	75	68	94	89	82	76	
150	78	72	66	59	79	74	67	61	83	78	73	68	
160	70	65	59	53	71	66	60	55	73	69	65	61	
170	63	58	53	49	63	59	55	50	65	62	58	55	
180	56	53	48	44	57	53	49	45	59	56	53	49	
190	51	48	44	40	51	48	45	41	53	51	48	45	
200	46	44	40	37	47	44	41	38	48	46	44	4	
210	42	40	37	34	42	40	38	35	43	42	40	38	
220	39	37	34	32	39	37	35	32	40	38	37	35	
230	35	34	32	29	36	34	32	30	36	35	34	32	
240	33	31	29	27	33	31	30	28	34	32	31	30	

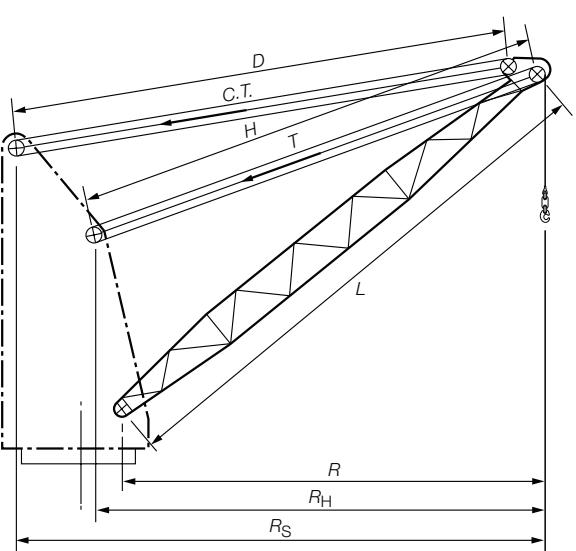


Fig. 3.2.5 Geometry for jib stability calculations

2.22 Allowable stress – Plate buckling failure

2.22.1 The allowable stress is to be taken as the critical buckling stress σ_{cb} , σ_{bb} , or τ_b as appropriate of the component concerned multiplied by the stress factor, F , as defined in Table 3.2.6.

2.22.2 For components subject to compression the critical buckling stress is given by:

(a) For $\sigma_{cb} < 0,5\sigma_y$

$$\sigma_{cb} = K_c E \left(\frac{t}{b} \right)^2$$

(b) For $\sigma_{cb} \geq 0,5\sigma_y$

$$\sigma_{cb} = \sigma_y \left(1 - \frac{\sigma_y}{4K_c E \left(\frac{t}{b} \right)^2} \right)$$

where

σ_{cb} = critical compression buckling stress, in N/mm²

K_c = compression buckling constant, see Fig. 3.2.6

E = Young's modulus, in N/mm²

t = plate thickness, in mm

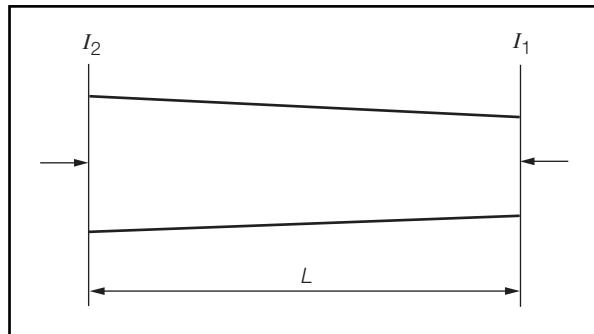
b = plate width, i.e. normal to direction of stress, in mm.

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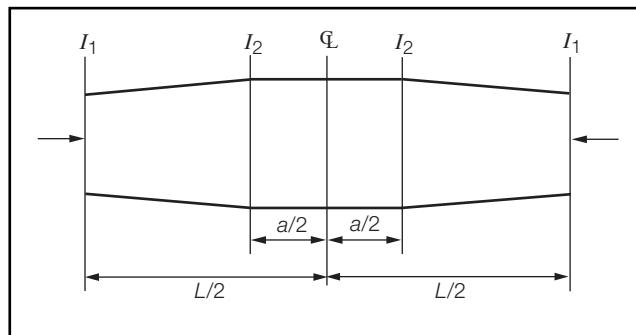
Section 2

Table 3.2.11 *m* factor for various values of I_1/I_2

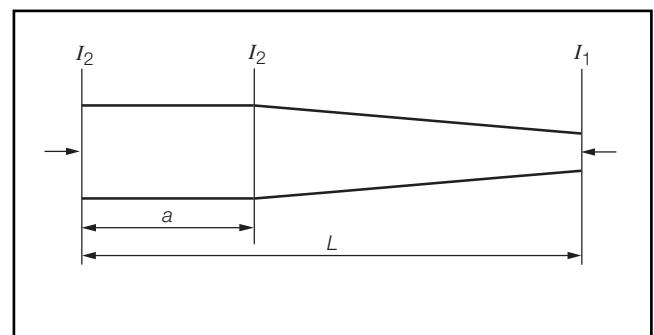
I_1/I_2	0	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0
<i>m</i>	0,294	0,372	0,474	0,559	0,634	0,704	0,769	0,831	0,889	0,946	1,0

**Table 3.2.12** *m* factor for various values of I_1/I_2 and a/L

I_1/I_2	a/L					
	0,0	0,1	0,2	0,3	0,4	0,5
0,1	0,555	0,622	0,689	0,756	0,823	0,891
0,2	0,652	0,708	0,765	0,821	0,877	0,934
0,4	0,776	0,815	0,854	0,894	0,933	0,972
0,6	0,866	0,890	0,915	0,940	0,964	0,988
0,8	0,938	0,950	0,961	0,973	0,985	0,996
1,0	1,0	1,0	1,0	1,0	1,0	1,0

**Table 3.2.13** *m* factor for various values of I_1/I_2 and a/L

I_1/I_2	a/L					
	0,0	0,1	0,2	0,3	0,4	0,5
0,1	0,372	0,373	0,418	0,479	0,563	0,671
0,2	0,474	0,500	0,532	0,586	0,660	0,756
0,4	0,634	0,667	0,691	0,729	0,783	0,852
0,6	0,769	0,795	0,810	0,836	0,869	0,913
0,8	0,889	0,950	0,961	0,973	0,985	0,996
1,0	1,0	1,0	1,0	1,0	1,0	1,0



2.22.3 For components subject to shear the critical buckling is given by:

(a) For $\tau_b < 0,29\sigma_y$

$$\tau_b = K_s E \left(\frac{t}{b} \right)^2$$

(b) For $\tau_b \geq 0,29\sigma_y$

$$\tau_b = 0,58\sigma_y \left(1 - \frac{0,58\sigma_y}{4K_s E \left(\frac{t}{b} \right)^2} \right)$$

where

- τ_b = critical shear buckling stress, in N/mm²
- K_s = shear buckling constants, see Fig. 3.2.7
- b = smallest plate dimension.

2.22.4 For component subject to bending stress, the critical buckling stress is given by:

(a) For $\sigma_{bb} < 0,5\sigma_y$

$$\sigma_{bb} = K_b E \left(\frac{t}{b} \right)^2$$

(b) For $\sigma_{bb} \geq 0,5\sigma_y$

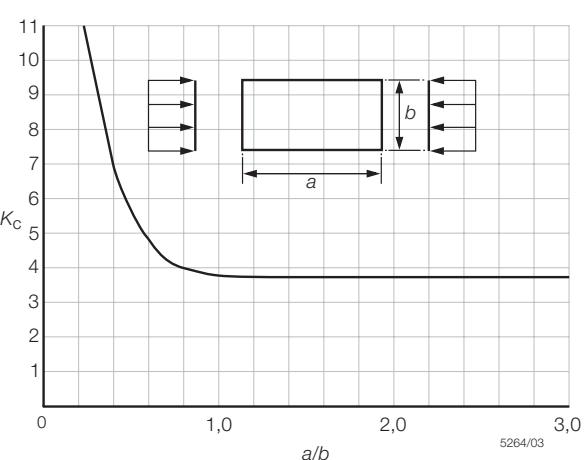
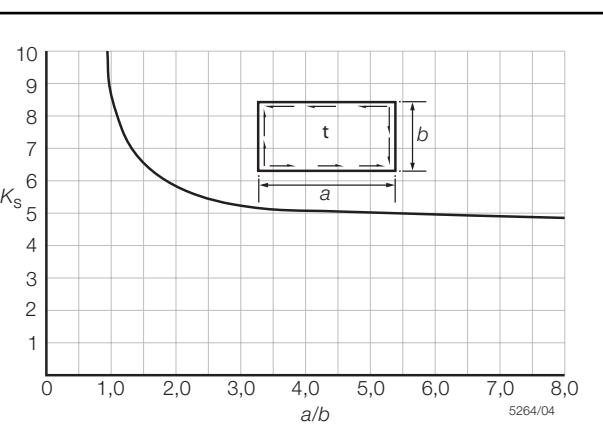
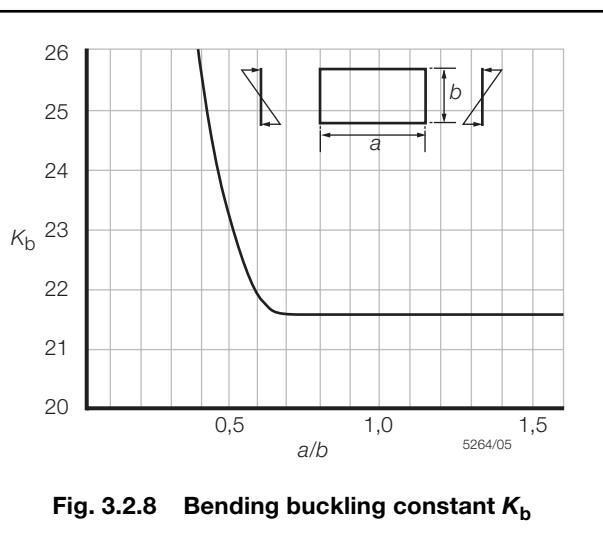
$$\sigma_{bb} = \sigma_y \left(1 - \frac{\sigma_y}{4K_b E \left(\frac{t}{b} \right)^2} \right)$$

where

- σ_{bb} = critical buckling stress, in N/mm²
- K_b = bending buckling constant, see Fig. 3.2.8
- b = plate width, i.e. normal to direction of stress, in mm.

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**Fig. 3.2.6 Compression buckling constant K_c** **Fig. 3.2.7 Shear buckling constant K_s** **Fig. 3.2.8 Bending buckling constant K_b**

2.22.5 For components subject to combined compression and shear, the following allowable stress criteria are to be met:

- (a) $\sigma_c < F \sigma_{cb}$
- (b) $\tau < F \tau_b$
- (c) $\left(\frac{\sigma_c}{\sigma_{cb}}\right) + \left(\frac{\tau}{\tau_b}\right)^2 < F$

τ = applied shear stress, in N/mm².

2.22.6 For components subject to combined bending and shear, the following stress criteria are to be met:

- (a) $\sigma_b < F \sigma_{bb}$
- (b) $\tau < F \tau_b$
- (c) $\left(\frac{\sigma_b}{\sigma_{bb}}\right)^2 + \left(\frac{\tau}{\tau_b}\right)^2 < F$

2.22.7 For components subject to combined bending and compression the following allowable stress criteria are to be met:

- (a) $\sigma_c < F \sigma_{cb}$
- (b) $\sigma_b < F \sigma_{bb}$
- (c) $\frac{\sigma_c}{\sigma_{cb}} + \left(\frac{\sigma_b}{\sigma_{bb}}\right)^2 < F$

2.22.8 For components subject to combined compression, bending and shear, the following allowable stress criteria are to be met:

- (a) $\sigma_c < F \sigma_{cb}$
- (b) $\sigma_b < F \sigma_{bb}$
- (c) $\tau < F \tau_b$
- (d) $\left(\frac{\tau}{\tau_b}\right)^2 + \left(\frac{\sigma_c}{\sigma_{cb}}\right) + \left(\frac{\sigma_b}{\sigma_{bb}}\right)^2 < F$

2.23 Allowable stress – Buckling failure of thin walled cylinders

2.23.1 The allowable stress is to be taken as the critical buckling stress σ_{cb} or σ_{bb} as appropriate of the component concerned multiplied by the allowable factor, F , as defined in Table 3.2.6.

2.23.2 For components subject to compression the critical buckling stress is given by:

- (a) For $\sigma_{cb}^1 < 0.5\sigma_y$
 $\sigma_{cb}^1 < K'_c E$
- (b) For $\sigma_{cb}^1 \geq 0.5\sigma_y$
 $\sigma_{cb}^1 = \sigma_y \left(1 - \frac{\sigma_y}{4K'_c E}\right)$

where

σ_{cb}^1 = critical compressive buckling stress, N/mm²

K'_c = compression buckling constant, see Fig. 3.2.9

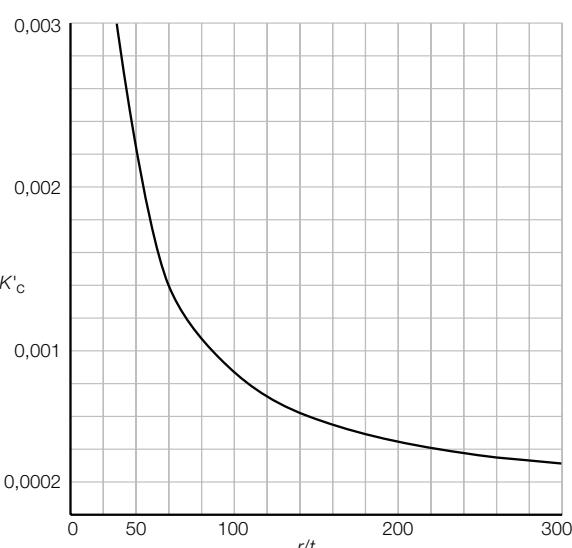
E = Young's modulus, in N/mm²

r = radius of tube, in mm

t = wall thickness, in mm.

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**Fig. 3.2.9 Compressive buckling constant**

2.23.3 For components subject to bending the critical buckling stress is given by:

(a) For $\sigma_{bb}^{-1} < 0,5\sigma_y$

$$\sigma_{bb}^{-1} = K'_b E$$

(b) For $\sigma_{bb}^{-1} \geq 0,5\sigma_y$

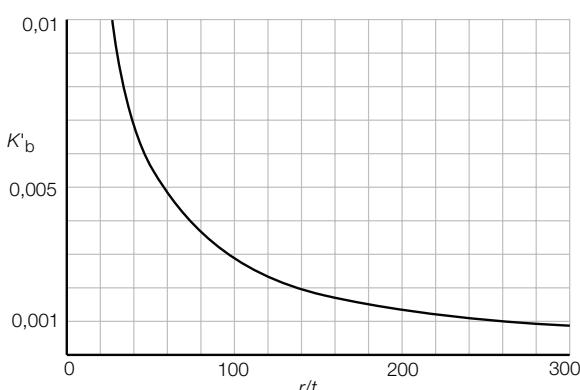
$$\sigma_{bb}^{-1} = \sigma_y \left(1 - \frac{\sigma_y}{4K'_b E} \right)$$

where

σ_{bb}^{-1} = critical bending buckling stress, in N/mm²

K'_b = bending buckling constant, see Fig. 3.2.10

E = Young's modulus, in N/mm².

**Fig. 3.2.10 Bending buckling constant**

2.23.4 For components subject to combined compression and bending the following allowable stress criteria are to be met:

$$\sigma_c < F \sigma_{cb}^{-1}$$

$$\sigma_b < F \sigma_{bb}^{-1}$$

$$\frac{\sigma_c}{\sigma_{cb}^{-1}} + \frac{\sigma_b}{\sigma_{bb}^{-1}} < F$$

2.24 Allowable stress – Joints and connections

2.24.1 For welded joints, the physical properties of the weld metal are considered as equal to the parent metal. For full penetration butt welds subjected to simple tension or compressive stresses the allowable stress is equal to the allowable tensile stress of the parent material.

2.24.2 For fillet welds and welds subjected to shear, the allowable stresses are reduced. Values of these reduced stresses are given in Table 3.2.14. Where F is the stress factor, see Table 3.2.6.

Table 3.2.14 Allowable stresses in welds, in N/mm²

Type of weld	Allowable stress	
	Tension and compression	Shear
Full penetration butt weld	1,0F σ _y	0,58F σ _y
Fillet welds	0,7F σ _y	0,58F σ _y

2.24.3 The actual stress in fillet welds is to be calculated on the 'throat' dimension of the weld.

2.24.4 The strength of joints using pretensioned bolts to transmit shear and/or tensile forces, e.g. high strength friction grip bolts, are to be determined in accordance with an appropriate national or other approved standard.

2.24.5 For joints using precision bolts, defined as turned or cold finished bolts fitted into drilled or reamed holes whose diameter is not greater than the bolt diameter by more than 0,4 mm, the allowable stress due to the externally applied load is given in Table 3.2.15.

Table 3.2.15 Allowable stresses for fitted bolts

Type of loading	Allowable stress	
	Load cases 1 and 2	Load cases 3 and 4
Tension	0,4σ _y	0,54σ _y
Single shear	0,38σ _y	0,51σ _y
Double shear	0,57σ _y	0,77σ _y
Tension and shear (σ _{yy} ² + 3τ ²) ^{1/2}	0,48σ _y	0,64σ _y
Bearing	0,9σ _y	1,2σ _y

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2.24.6 Where joints are subjected to fluctuating or reversal of load across the joint the bolts are to be pre-tensioned by controlled means to 70 to 80 per cent of their yield stress.

2.24.7 Black bolts (ordinary grade bolts) are not to be used for primary joints or joints subject to fatigue.

2.25 Slewing ring and slewing ring bolting

2.25.1 The crane manufacturer is to submit plans of the slewing ring, the bolting arrangement, crane and pedestal structure in way of the slewing ring and calculations giving static and fatigue design loads and allowable stresses for the ring and bolting arrangement.

2.25.2 The ring mounting flanges are to be rigid and the bolting equally spaced around the complete circumference of the ring. Mating surfaces are, in general, to be steel to steel and packing material is not recommended between joint faces.

2.25.3 Bolts are to be of ISO 898/1 material Grade 8.8, 10.9 or 12.9 or equivalent and are to be pretensioned by controlled means to 70 to 90 per cent of their yield stress. Pretensioning is to be in accordance with the bearing manufacturer's instructions and, in general, pretensioning by bolt torqueing up to bolt size M30 may be used. Beyond this, pretensioning must be carried out by hydraulic tensioning device and elongation of the bolts measured to determine pre-load.

2.25.4 The load, due to external loading, on the most heavily loaded bolt is given by:

$$P = \frac{4M}{ND} - \frac{H}{N}$$

where

- M = design overturning moment, in N mm
- H = design axial load, in newtons
- D = pitch circle diameter of bolts, in mm
- N = number of bolts.

2.25.5 The allowable tensile stress for bolts to ISO 898/1 grade associated with the external loading of 2.25.4, and pretensioned in accordance with 2.25.3 are given in Table 3.2.16.

Table 3.2.16 Allowable stress in ISO 898/1 bolts

International standard ISO 898/1 designation	Allowable stress, in N/mm ²	
	Load cases 1 and 2	Load cases 3 and 4
8,8	256	343
10,9	360	482
12,9	432	579

2.26 Materials

2.26.1 The crane is to be constructed of steel which complies with LR's requirements for hull structural steel. Alternatively steels which comply with national specification may be used provided these specifications give reasonable equivalence to Rule requirement.

2.26.2 The selected steel grade is to provide adequate assurance against brittle fracture taking into account the material tensile strength and thickness and the environment in which the crane is designed to operate, see Chapter 8, and is in general, to comply with the Charpy test requirements given in Table 3.2.17.

Table 3.2.17 Charpy V notch test requirements

Thickness, in mm	Charpy test temperature, in °C	Maximum tensile strength, in N/mm ²		
		540	590	630
$t \leq 20$	Room temperature*	27	31	34
$20 < t \leq 30$	0	27	31	34
$30 < t \leq 40$	-10	27	31	34
$40 < t \leq 50$	-20	27	31	34
$50 < t \leq 130$	-40	27	31	34

NOTE
*Charpy impact test is not required provided the carbon content is not greater than 0,23 per cent and the manganese content is not less than 2,5 times the carbon content.

2.26.3 Special consideration will be given to proposals to use materials which do not meet the requirements of Table 3.2.17 where it can be shown that satisfactory service experience has resulted from the particular materials and construction.

2.27 Rope safety factors and sheave ratio

2.27.1 The rope safety factor for both running and standing application for cranes with SWL greater than 10 t and less than 160 t is given by:

$$SF = \frac{10^4}{8,85L + 1910}$$

where

SF = minimum safety factor required

L = safe working load of crane, in tonnes

For cranes with $SWL < 10$ t, $SF = 5,0$

and $SWL > 160$ t, $SF = 3,0$.

This is represented graphically in Fig. 3.2.11.

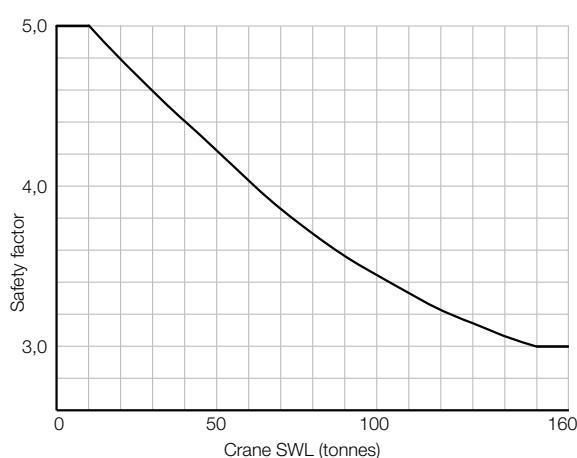


Fig. 3.2.11 Rope safety factor v. crane SWL

2.27.2 The required minimum breaking load of the rope is given by:

$$BL = SF \times L_r$$

where

BL = the required minimum breaking load of the rope, in newtons

L_r = the load in the rope due to consideration of the unfactored live load and jib weight as appropriate taking due account of the number of parts in the rope system and the friction in the sheaves over which the rope passes, in newtons. See Ch 2,2.4.

2.27.3 The ratio of the bottom of the rope groove diameter of the sheave to wire rope diameter is to be not less than 19 to 1.

■ Section 3

Offshore cranes

3.1 General

3.1.1 This Section applies to cranes which are designed to operate in offshore conditions. These are defined as open sea environment in which there is significant movement of the ship or installation, on which the crane is mounted or from which the crane is off loading, due to wave action. The sea state will, generally, be in excess of that described by Beaufort No. 2.

3.1.2 Cranes mounted on offshore installations used solely for lifting operations on the installation itself may be considered as shipboard cranes as defined in Section 2.

3.1.3 The requirements of Section 2 are to apply to offshore crane design except where specific requirements are defined in this Section.

3.1.4 The scope of this Section covers jib cranes, 'A' frames and fixed structures used for lifting operations. Travelling gantry or mobile cranes will be specially considered on the general basis of these requirements.

3.2 Service category and duty factor

3.2.1 A single service category and associated duty factor, $F_d = 1,20$ is to be used for all offshore cranes.

3.3 Dynamic forces

3.3.1 The dynamic force due to hoisting for offshore cranes is to include the effect of relative movement of the crane and load in addition to normal hoisting shock and dynamic effects.

3.3.2 The hoisting factor is considered to be dependent on the design operational sea conditions which may be defined by the Beaufort No., Sea State No. or wave height and period, and is to be calculated from the following expression:

$$F_h = 0,83 + F_w \sqrt{\frac{K}{L_1}}$$

where

F_w = a factor dependent on the design operational sea condition and obtained from Table 3.3.1

K = the crane system stiffness, in N/mm

L_1 = live load, in newtons.

For initial design calculations $\sqrt{\frac{K}{L_1}}$ may be taken as 0,057.

3.3.3 To calculate the crane system stiffness the following combination of structural elements are to be considered:

- (a) hoist rope system;
- (b) luffing rope system;
- (c) crane jib.

For wire ropes Young's modulus is to be taken as $0,0625 \times 10^6$ N/mm² associated with an area based on the nominal diameter of the rope.

3.3.4 When the design operational sea conditions are known, the hoist factor may be calculated from the following expression:

$$F_h = 0,83 + 45,5 \frac{H}{T} \sqrt{\frac{K}{L_1}}$$

where

H = design wave height, in metres

T = design wave period, in seconds

F_h is to be taken as not less than that given in 2.5.

3.3.5 When a motion compensator, shock absorber, or similar device is fitted, proposals to use lesser hoist factors will be specially considered.

3.3.6 As an alternative to the method of determining the dynamic forces indicated in 3.3.1 to 3.3.4, consideration will be given to submissions based on a dynamic analysis of the crane structure.

Table 3.3.1 Minimum hoist speed, wave factor and offlead angle for various sea conditions

Beaufort No.	Sea state No.	Description of sea condition	Wind speed range, m/s	Significant wave height, $H_{1/3}$ m	Minimum hoist speed, V_h m/s	Wave factor, F_w	Offlead angle in degrees			
							Case 1		Case 2	
							α	β	α	β
2	1	Small wavelets, short but more pronounced, crests have glossy appearance but do not break	2,0–3,1	0,6	0,2	8,1	5	2	2	5
4	2–3	Small waves, becoming larger: fairly frequent white horses	5,7–8,2	1,6	0,33	13,7	6	3	3	6
6	5–6	Large waves begin to form: the white foam crests are more extensive everywhere: probably some spray	11,3–13,9	3,9	0,46	21,7	8	4	4	8
8	7	Moderately high waves of greater length: edges of crest break into spindrift. The foam is blown in well marked streaks along the direction of the wind. Spray affects visibility	17,5–20,6	7,0	0,64	33,3	12	6	6	12

NOTES

1. α = offlead in plane of jib.
2. β = offlead normal to plane of jib.

3.4 Offlead angles

3.4.1 The design offlead angles are related to sea condition and are given in Table 3.3.1. Examination is to be carried out for both cases unless it can be shown that either case is not applicable. Similarly, proposals to use lesser values will be specially considered where arrangements to reduce the offlead angle exist.

3.4.2 In addition to the operating conditions the crane and its stowage arrangements are to be designed to withstand the most severe combination of motions which can occur when the crane is stowed. In the case of ship mounted cranes reference should be made to Section 2.

3.5 Hoisting speed

3.5.1 When a load is lifted from a ship, the load hoist speed is to be high enough to ensure that after the load is lifted a second wave does not cause the ship to re-contact the load. The minimum load hoist speed to avoid re-contact for the various sea conditions is given in Table 3.3.1.

3.5.2 When the design wave height and period are specified the load hoist speed may be obtained from the following expression:

$$V_h = 0,9233 \frac{H}{T}$$

where

V_h = the minimum hoist speed to avoid re-contact, in m/s.

3.6 Slew rings

3.6.1 Slew rings for offshore cranes are to be constructed of steel having an average Charpy V-notch impact value at minus 20°C of 42 J taken from three samples with a lowest single value not less than 27 J. Steel having lower values to ensure adequate bearing properties and where the design is such as to minimize notch effect will be specially considered.

3.6.2 In general, the ring is to be manufactured from steel having an ultimate tensile strength of range 820 to 1100 N/mm² and an elongation, based on a gauge length of five diameters, of not less than 15 per cent.

3.6.3 Type testing, whereby a sample of the critical part of the ring is tested statically and with respect to fatigue to prove the adequacy of other rings manufactured to the same specification, standard and methods, is to be carried out for three roller type bearings and other designs where provision of fillet radii of the bearing surfaces are considered to introduce stress concentrations in a failure path which would result in the loss of the crane.

3.6.4 The ring is to be considered with respect to static loads resulting from the worst load combination of 2.16.1 and associated with an allowable stress obtained from test in accordance with 3.6.3 multiplied by a stress factor = 0,4.

3.6.5 The ring is also to be considered with respect to fatigue loading based on load combination Case 2 of 2.16.1, multiplied by a load spectrum factor of 0,7 and associated with an allowable stress determined from S-N curves obtained from the type testing of 3.6.3 on the basis of 2×10^6 cycles and multiplied by a stress factor = 0,67.

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3.6.6 The slewing ring bolts are to be made from steel having impact properties as given in 3.6.1 and where necessary the threads may be rolled after heat treatment to improve fatigue strength. In general, the steel grade is not to exceed ISO 898/1 Grade 10.9.

3.6.7 The bolts are to be pretensioned in accordance with 2.25.3 and are to be considered with respect to the static and fatigue design conditions of 3.6.4 and 3.6.5 taking due account of pretension.

3.6.8 In addition to the above design requirements, the slew ring is to be manufactured under survey and LR's Surveyor will be required to witness the following aspects of the inspection procedure during its manufacture:

- (a) Testing of samples from the actual slew ring forging to ensure that the requirements of 3.6.1 and 3.6.2 are complied with.
- (b) Type testing of the slew ring to determine the static and fatigue strengths as required by 3.6.3.
- (c) Magnetic particle examination of the machine finished components of the ring to ensure that they are free from cracks, etc.

3.7 Materials

3.7.1 The crane is to be constructed of steel which complies with LR's requirements for hull structural steel. Alternatively, steels which comply with national specifications may be accepted provided they give reasonable equivalence to rule requirement.

3.7.2 The selected steel grade is to provide adequate assurance against brittle fracture and is to be suitable for a design operating temperature of -10°C . Account is to be taken of the material tensile strength, thickness and the environment in which the crane is designed to operate, see Chapter 8.

3.7.3 The steel for primary and secondary structural members is to comply with the Charpy V-notch test requirements given in Table 3.3.2. The test temperature is specified in relation to the material thickness and the energy value according to the actual tensile strength.

3.7.4 For design operating temperatures below -10°C the Charpy V-notch test requirements will be specially considered.

3.8 Rope safety factors

3.8.1 The rope SF for offshore cranes is to be determined from the following expression:

$$SF_n = SF_2 \times \frac{F_{hn}}{1,6}$$

where

- SF_n = safety factor required at Beaufort No. n, but is to be taken as not less than that obtained from 2.27
- SF_2 = safety factor obtained from 2.27
- F_{hn} = hoisting factor derived in accordance with 3.3.

3.8.2 The required breaking load of the rope is given by:

$$BL = SF_n \times L_r$$

where

- BL = required breaking load of the rope, in newtons
- L_r = actual load in the rope derived in accordance with 2.27

NOTE

In the case of luffing ropes, the ratio $F_{hn}/1,6$ need only be applied to the live load component of the total rope tension.

3.9 Motion compensators

3.9.1 Where it is proposed to install a motion compensator or shock absorber device to reduce the impact load applied to the crane with a view to improving its rating this will be specially considered and, in general, subject to the following procedure:

- (a) Plans, calculations and proposed test procedures are to be submitted for approval.
- (b) Units are to be manufactured and tested under survey.
- (c) Testing to include 'in factory' tests under simulated design offshore conditions together with normal proof test requirements.
- (d) For initial approval of new devices the crane installation is to be instrumented to enable maximum load in hoist system to be monitored for various sea conditions and SWL and result submitted for consideration.

Table 3.3.2 Charpy V-notch test requirements

Primary structure	Secondary structure	Thickness, in mm	Charpy test temperature, in $^{\circ}\text{C}$	Actual maximum tensile strength		
				540	590	630
			Charpy V-notch energy, in J			
$t \leq 10$	$t \leq 20$		Room temperature*	27	31	34
$10 < t \leq 15$	$20 < t \leq 30$		0	27	31	34
$15 < t \leq 20$	$30 < t \leq 40$		-10	27	31	34
$20 < t \leq 25$	$40 < t \leq 50$		-20	27	31	34
$25 < t \leq 60$	$50 < t \leq 60$		-40	27	31	34

NOTE

* Test may be omitted provided carbon content is not greater than 0,23 per cent and the manganese content is not less than 2,5 times the carbon content.

■ **Section 4****Submersible handling systems****4.1 General**

4.1.1 This Section applies to installations which are designed to handle manned submersibles in offshore conditions. Offshore conditions are defined as those which exist in an open sea environment in which the sea state does not exceed that described by Beaufort No. 5. Special consideration will be given to cases where service in a more severe sea state is envisaged.

4.1.2 The requirements of Section 2 are to apply to submersible handling systems except where specific requirements are defined in this Section. Systems for handling unmanned submersibles may be designed on the basis of Section 3.

4.2 Service category and duty factor

4.2.1 A single duty factor is to be used for all manned submersible handling systems. The duty factor, F_d , is to be taken as 1,2.

4.3 Basic loads

4.3.1 The live load, L_1 , to be used for submersible handling systems is to be taken as the greater of:

- (a) The maximum in air weight of the submersible and exposed length of hoisting rope.
- (b) The maximum weight of the exposed length of hoisting rope, together with the combined in water weight of the submersible and submerged length of rope.

4.3.2 Where the handling system does not lift the submersible through the air/water interface the live load may be taken as that defined in 4.3.1(b).

4.4 Dynamic forces

4.4.1 The hoisting factor, F_h , to be used for submersible handling systems incorporates the effects of the submersible passing through the water/air interface and is to be taken as 1,7.

4.5 Offlead angles

4.5.1 Submersible handling equipment operates in an offshore environment where there is significant movement of the ship and/or submersible due to wave action. To allow for these conditions an offlead angle of 10° assumed to be acting in both planes simultaneously is to be used for design purposes.

4.6 Stowage arrangements

4.6.1 In addition to the operating conditions the installation is to be designed to withstand the most severe combination of motions which can occur when the handling system is stowed. In the case of ship mounted installations reference should be made to Section 2.

4.6.2 It additionally may be necessary to consider the effects of 'green sea' loading, in which case a value of 8400 N/m² is to be used as an equivalent hydrostatic pressure.

4.7 Materials

4.7.1 Materials are to comply with the requirements of 3.7.

4.8 Rope safety factors

4.8.1 The safety factor for ropes used for manned submersibles is to be taken as 8,0 for steel wire ropes and 10,0 for man made fibre ropes.

4.8.2 The safety factor for wire ropes used for unmanned submersibles is to be obtained from 3.8.1, but is to be taken as not less than 6,0.

4.8.3 The safety factor for man made fibre ropes used for unmanned submersibles is to be obtained from 4.8.2 multiplied by 1,25.

4.8.4 If in addition to the primary hoist rope a secondary system of recovery is employed using another hoist rope the minimum safety factor for this is to be not less than 5,0.

■ **Section 5****Pedestals and foundation****5.1 General**

5.1.1 Crane pedestals for ship mounted cranes are a classification item. Pedestals on offshore installations will be considered on the same basis as the main support structure.

5.1.2 The loading conditions as defined in Sections 2, 3 and 4 are to be applied in association with the allowable stress levels contained in this Section.

5.1.3 Pedestals, in general, are to be carried through the deck and satisfactorily scarphed into the hull or main support structure. Proposals for other support arrangements will be specially considered.

5.1.4 The pedestal flange in way of the slew ring bearing is to be designed and be of a thickness to provide a rigid and level support for the bearing and bolting. Tolerances and arrangements proposed by the slew ring bearing manufacturer are to be adhered to.

5.1.5 Where it is considered necessary to introduce stiffening brackets to support the flange the spacing of the brackets is to be not greater than that achieved by positioning them between every second bolt.

5.2 Design loads

5.2.1 The pedestal is to be designed with respect to the worst possible combination of loads resulting from the crane self weight, live load, wind and crane accelerations together with those resulting from the ship's heel and trim.

5.2.2 Stowage arrangements are to be taken into account when calculating the loads applied to the pedestal.

5.3 Allowable stresses

5.3.1 The allowable stress is to be taken as the failure stress of the component concerned multiplied by stress factor, F_p , which depends on the load case concerned. The allowable stress is given by the general expression:

$$\sigma_a = F_p \sigma$$

where

σ_a = allowable stress, in N/mm²

F_p = stress factor

σ = failure stress, in N/mm².

5.3.2 The stress factors for steel with $\frac{\sigma_y}{\sigma_u} \leq 0,7$ are given

in Table 3.5.1:

where

σ_y = yield stress of material, in N/mm²

σ_u = ultimate tensile failure stress of the material in N/mm².

Table 3.5.1 Stress factor, F_p

Load case	1	2	3 and 4
Stress factor, F_p	0,5	0,57	0,64

5.3.3 For steel where $\frac{\sigma_y}{\sigma_u} > 0,7$ the allowable stress is

to be derived from the following expression:

$$\sigma_a = 0,41F_p(\sigma_u + \sigma_y)$$

5.3.4 The failure stresses for the various failure modes are as defined in Section 2.

5.4 Materials

5.4.1 Crane pedestals are to be constructed of steels which conform to LR's *Rules for the Manufacture, Testing and Certification of Materials* and *Rules and Regulations for the Classification of Mobile Offshore Units* (hereinafter referred to as the Rules for Mobile Offshore Units), as appropriate.

5.4.2 The grade of steel for pedestals for ship mounted cranes is to be selected in accordance with Table 3.5.2.

Table 3.5.2 Steel grade requirements

Plate thickness, in mm	LR steel grade
$t \leq 20,5$	A/AH
$20,5 < t \leq 25,5$	B/AH
$25,5 < t \leq 40,0$	D/DH
$t > 40$	E/EH

5.4.3 The grade of steel for pedestals on offshore installations or manned submersible handling installations is to comply with the requirements of 3.7.

Section	
1	General
2	Structural design criteria
3	Testing
4	Classification Regulations
5	Certification requirements

■ Section 1 **General**

1.1 Scope

1.1.1 The requirements of this Chapter are applicable to mechanical lift dock systems in which vessels are raised and lowered by means of winches or jacks when docked on a flexible or rigid platform structure.

1.1.2 The vessel may be docked on a system of blocks, cradles or an air/hydraulic cushion arrangement for subsequent transfer.

1.1.3 Docking systems which incorporate a combination of both mechanical lift dock and floating dock principles will be specially considered on the basis of these requirements and Lloyd's Register's (hereinafter referred to as LR) *Rules and Regulations for the Construction and Classification of Floating Docks* (hereinafter referred to as the Rules for Floating Docks).

1.1.4 In those cases in which the installation is to be certified but not classed, the design criteria specified assume that Periodical Survey procedures, at least equivalent to LR's, will be adhered to by the Owner. This is of particular importance with respect to ropes and chains used to raise the platform.

1.1.5 When specifically requested, end and side transfer arrangements will be examined and included in the class notation or certification issued. However, where the design concept of the platform involves an interaction or interdependence between the platform and transfer system, as in the case of a rigid platform with flexible ship support system, the transfer system will be considered as an essential and integral aspect of class or certification.

1.1.6 All foundations and civil engineering work are excluded from LR's involvement.

1.1.7 These requirements are framed on the understanding that the installation will be properly loaded and operated. They do not allow for concentrations of loading greater than indicated by the specified maximum distributed load nor for loading situations or weather conditions which may result in the rated capacity of individual winches being exceeded.

1.1.8 Sufficient information is to be supplied to the operator, in the form of an operations manual, to ensure the safe operation of the installation.

1.2 Procedure

1.2.1 The following procedure is to be adopted for all installations where LR's classification or certification is required:

- (a) Approval of plans covering structural, electrical, mechanical, hydraulic and control engineering aspects of the installation as indicated in Ch 1,3.3. Supporting calculations are to be submitted as may be required and these are to indicate clearly the proposed lifting capacity and the docking and transfer arrangement for which approval is required.
- (b) Survey of steelwork and winches at the place of manufacture and verification of materials.
- (c) Certification, on the appropriate forms, of wire ropes and chains which are to be manufactured at a works approved by LR.
- (d) Survey of structure, winches, electrical and hydraulic systems during installation and on site assembly.
- (e) Periodical Surveys and tests are to be carried out as specified in Section 4.

1.3 Lifting capacity

1.3.1 For the purpose of classification or certification, each mechanical lift dock will be designated a lifting capacity on the following basis:

- (a) Maximum distributed load (MDL)
This is the maximum load, in tonnes/metre, which can be uniformly distributed along the centreline of the platform, and which has been used to establish the scantlings of the installation. It is to be taken as:
(Capacity of one pair of hoists minus deadweight of the length of platform associated with these hoists) divided by the hoist spacing.

- (b) Nominal lifting capacity (NLC)
This is the maximum displacement, in tonnes, of a ship of normal form which can be lifted without exceeding the maximum distributed load for which the platform is designed, and is to be taken as:

$$NLC = MDL \times \text{effective platform length} \times \text{a distribution factor.}$$

These values will appear on the appropriate certificates issued by LR.

1.3.2 The maximum distributed load on the platform includes the weight of cradles or blocks used for supporting the ship.

1.3.3 The effective platform length is the total length between hoists plus the lengths of the end cantilevers, but each of these is to be taken as not greater than one half of the hoist spacing.

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Chapter 4

Sections 1 & 2

1.3.4 The distribution factor is to ensure that the maximum distributed load is not exceeded anywhere along the effective length of the platform and to allow for dynamic factors. The following values are generally to be adopted:

- (a) Platforms of articulated design (that is with no longitudinal stiffness or bending rigidity) and incorporating conventional block or cradle arrangements: 0,67.
- (b) Platforms of articulated design incorporating flexible cradles, or platforms of rigid design incorporating flexible or rigid cradles: calculations to be submitted but in no case to exceed 0,83.

1.3.5 The total net lifting capacity of the installation is defined as the MDL x effective platform length. Where requested, this value may be included in the certification for information purposes only.

1.3.6 The lifting capacities will be specially considered in cases where:

- (a) The block or cradle arrangement is such that the loads are not applied along the centreline of the platform.
- (b) The design incorporates different maximum distributed loads along the length of the platform.

1.3.7 The block or cradle arrangement is, in general, to be such as to ensure that the pressure on the hull of a docked ship is not greater than that for which its structure is suitable. In general, this pressure is in the range 200 to 230 t/m². Particular circumstances may, however, result in a greater or lesser pressure being appropriate.

1.4 Machinery, control and operational features

1.4.1 The arrangements in respect of electrical, mechanical, hydraulic and control engineering aspects of the installation are to comply with the requirements of Chapter 7.

Section 2

Structural design criteria

2.1 Loading

2.1.1 The design is to be based on the maximum distributed load per metre applied as a keel block loading along the centreline of the platform, see also 1.3.6.

2.1.2 The platform structure in way of bilge blocks is to be designed for 20 per cent of the maximum distributed load per metre. This figure takes into account the effect of wind loading on the ship equivalent to 2,5 kN/m² (corresponding to a wind speed of 64 m/s).

2.1.3 The above loading is to be applied over the docking length of the platform and to the shore end of the platform where transfer takes place.

2.1.4 The access and decked-in areas of the platform are also to be designed for:

- (a) a superimposed load of 5,0 kN/m², uniformly distributed; and
- (b) a point load of 10 kN at any one point;

but higher values may be required to meet operational or equipment criteria. These loadings will not, normally, influence the lifting capacity specified in 1.3.1 nor the design loading given in 2.1.1 and 2.1.2.

2.1.5 Consideration is to be given to the horizontal forces arising from wind loading and transfer operations. The horizontal strength of the platform is to be capable of resisting the following forces:

- (a) During transfer operations: a total horizontal force of 250 N/m² on the projected area of the docked vessel, plus the effects of the forces required to overcome friction in the transfer system. The friction force is to be taken as 2 per cent of the cradle wheel loads when roller bearings are fitted to the wheels, and 4 per cent when plain or bushed bearings are fitted.
- (b) Where a vessel is supported on the platform and transfer operations are not being carried out: a total horizontal force calculated from a wind loading of 2,5 kN/m² (corresponding to a wind speed of 64 m/s) on the projected area of the docked vessel.

2.1.6 Resistance to these forces may be provided by one or more of the following methods:

- (a) A horizontal bracing system.
- (b) A horizontal rigid platform.
- (c) An adequate decking acting as a horizontal girder.

2.2 Allowable stresses

2.2.1 The allowable stresses in any part of the structure are not to exceed the values given in Table 4.2.1. These values apply to steel for which σ_y / σ_u is not greater than 0,7. Steels which have a ratio greater than 0,7 will be specially considered.

Table 4.2.1 Allowable stresses

Mode of stress	Allowable stress	Remarks
Direct tension or bending	$0,67\sigma_y$	
Compression	$0,67\sigma_y$	Members subjected to buckling failure are also to comply with Chapter 3
Shear	$0,35\sigma_y$	
Bearing	$0,90\sigma_y$	

2.2.2 The allowable stresses may be reduced in areas where openings in the structure may lead to the creation of stress concentrations.

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Sections 2 & 3

2.2.3 The allowable stresses in sheaves, shackles and other loose items are to comply with the requirements of Chapter 6.

2.2.4 Items of structure which are subjected to wind forces only may be determined on the basis of the above stresses increased by 25 per cent.

2.3 Rope and chain factors of safety

2.3.1 The safety factor required for ropes used to raise and lower the platform is to be not less than 3 to 1 based upon the certified breaking strength of the rope and the maximum rope tension. The maximum rope tension is to be calculated from the rated capacity of the hoists with an allowance for the cumulative effect of sheave friction and wire rope stiffness of 2 per cent for ball or roller bearings and 5 per cent for plain or bushed bearings.

2.3.2 The safety factor required for chains used to raise and lower the platform is to be not less than 3,0 to 1,0 based upon the certified breaking strength of the chain and the maximum chain tension. The maximum chain tension is to be based upon the rated capacity of the hoist. In view of the possibility of stress corrosion cracking, grade 80 or similar type, alloy chain should not be used.

2.3.3 Increased safety factors may be required where:

- (a) The hoisting speed of the platform exceeds 0,5 m/mm.
- (b) The mode of operation of the hoist system may produce significant shock loading.
- (c) A less onerous inspection replacement programme than LR's is envisaged in the case of installations certified but not classed.

2.4 Materials

2.4.1 Materials are to comply with the requirements of Chapter 8.

2.4.2 Where the installation is to be classed, the steel is, generally, to comply with the requirements of the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials). The grade of steel used for structural members is to be as follows:

Thickness, $t \leq 20,5$ in mm	$20,5 < t \leq 25,5$	$25,5 < t \leq 40$	$40 < t$
Grade	A/AH	B/AH	D/DH

2.4.3 Consideration may, however, be given to steel complying with an appropriate national standard, but tests to the satisfaction of the Committee will be required to demonstrate the suitability of the steel.

2.4.4 Alternative proposals in respect of the notch tough characteristics of the material will be considered when the service location of the particular installation is such that low temperatures are not climatically probable.

■ Section 3 Testing

3.1 General

3.1.1 The test criteria specified in this Section are applicable to all installations where the control system has an acceptable method of measuring the actual load on each individual hoist and where overhoist and overload cut outs and levelling devices are fitted in accordance with Chapter 7.

3.1.2 The test criteria will be specially considered where an inherent feature of the design requires a departure from these safety control requirements.

3.1.3 In all cases, a detailed test procedure based upon the requirements of this Section is to be submitted for approval.

3.1.4 Loose gear, ropes and chains are to be in accordance with the requirements of Chapter 9.

3.1.5 National Authorities may have more onerous test requirements than LR's and it is the Owner's responsibility to ensure that these are complied with.

3.2 Load tests

3.2.1 Light running tests on each winch unit are to be carried out at the manufacturer's works. It is strongly recommended that all winch units are also proof tested at the manufacturer's works to the loads given in Table 4.3.1.

Table 4.3.1 Proof loads for winches and cradles

Rated capacity, SWL	Proof load, in tonnes
Up to 20 t	1,25 x SWL
Exceeding 20 t but not exceeding 50 t	SWL + 5
Exceeding 50 t	1,1 x SWL

3.2.2 The winch rated capacity (SWL) is normally based upon the line pull multiplied by the number of parts supporting the platform.

3.2.3 The platform is to be load tested following installation on site:

- (a) in an unloaded or partially loaded condition; and
- (b) to 100 per cent of the total lifting capacity.

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Sections 3 & 4

3.2.4 The unloaded or partially loaded test is to be carried out to demonstrate the efficient operation of the platform systems.

3.2.5 The 100 per cent load test is to be based upon the rated capacity of each winch derived from the maximum distributed load per metre of the platform. This test may be carried out in stages by testing opposite pairs or sets of winches together if the size of the installation prohibits the provision of adequate test loads.

3.2.6 Where staged testing is adopted for rigid platform designs, it is to be ensured that each winch is subjected to its rated capacity.

3.2.7 Where desired, the winches may be proof tested on site by increasing the 100 per cent load test referred to in 3.2.5 to the appropriate value obtained from Table 4.3.1.

3.2.8 Cradles are to be individually tested with a proof load in accordance with Table 4.3.1 based upon the rated capacity of the cradles.

3.3 Operational test

3.3.1 In addition to the load tests in 3.2, a complete operational test is to be carried out at approximately the nominal lifting capacity of the installation. This is to be performed over the full cycle of operations, that is, hoisting, transfer ashore, transfer to platform and lowering.

3.3.2 Where, for practical considerations, it is not possible to test to the full nominal lifting capacity, this test may be carried out with a reduced test load but not less than 60 per cent of the nominal lifting capacity.

3.3.3 Transfer operations will be restricted to the tested displacement until such times as a ship of suitable displacement is available to test the installation to the full nominal lifting capacity. This full operational test is generally to be carried out within one year of the completion of the installation.

■ Section 4 Classification Regulations

4.1 General

4.1.1 Mechanical lift docks built in accordance with LR's Rules in respect of structural and machinery requirements will also be eligible to be assigned a class in the *Register Book* and will continue to be classed so long as they are found upon examination at the prescribed surveys to be maintained in accordance with LR's requirements.

4.1.2 The Regulations for classification and Periodical Surveys are given in Part 1 of LR's Rules for Ships. These Regulations will be applied to the mechanical lift docks and transfer systems insofar as they are applicable and are to be read in conjunction with the specific requirements given in this Chapter.

4.1.3 Where the proposed installation is novel in design, or involves the use of unusual materials, or where experience, in the opinion of the Committee, has not sufficiently justified the principle or mode of application involved, special tests or examinations before and during service may be required. In such cases, a suitable notation will be inserted in the *Register Book*.

4.2 Character of classification and class notation

4.2.1 Mechanical lift dock installations, when classed, will be assigned one or both of the following character symbols, as applicable:

☒ This distinguishing mark will be assigned, at the time of classing, to new installations constructed under LR's Special Survey, in compliance with the Rules and to the satisfaction of the Committee.

A This character letter will be assigned to all installations which have been built or accepted into class in accordance with LR's Rules and Regulations, and which are maintained in good, efficient condition.

4.2.2 A class notation will be appended to the character of classification assigned to the installation and this will also indicate whether the transfer system is included in LR's classification. The character of classification and class notations assigned will, normally, be as follows:

- (a) **☒A** or **A** – Mechanical lift dock for service at (port to be specified); or
- (b) **☒A** or **A** – Mechanical lift dock and transfer system for service at (port to be specified).

4.2.3 Special features or design principles may require variations from these typical class notations, and appropriate additional or amended notations may be assigned.

4.3 Initial Survey

4.3.1 Where it is intended to build the installation for classification with LR, constructional plans and all necessary particulars are to be submitted for the approval of the Committee before the work is commenced. Any subsequent modifications or additions to the scantlings or arrangements shown in the approved plans are also to be submitted for approval.

4.3.2 New installations are, from the commencement of the work until completion and installation, to be examined by the Surveyors with respect to materials, workmanship and arrangements. Any items not in accordance with LR's requirements or the approved plans, or any material, workmanship or arrangement found to be unsatisfactory are to be rectified.

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4.3.3 The requirements for weld procedure tests and weld inspection are to be agreed with the Surveyors. In general, however, it is recommended that non-destructive testing of welding to primary members should be as follows:

- (a) All fillet and butt welds in the area of support for sheave housings, transverse butt welds in main girders and similar critical areas.
- (b) 10 per cent of all other fillet and butt welds in primary structural members.

4.4 Periodical Surveys

4.4.1 Periodical Surveys are to be carried out on a 4-yearly Continuous Survey on the basis of the requirements of 4.4.2 to 4.4.13.

4.4.2 25 per cent of main and secondary transverse and longitudinal girders are to be examined. (This may require the removal of limit switch operating rods to enable submerged areas of the platform to be raised clear of the water). The examination is to include:

- (a) The connection or seating arrangements at the junction of longitudinal and transverse girders for signs of work hardening and cracking and other defects.
- (b) A general examination of protective coatings.
- (c) Examination of the rails for alignment and sign of wear giving particular attention to connecting arrangements and the connecting rail between the platform and shore.

Timber decking is to be removed as necessary to allow these examinations.

4.4.3 The Surveyor is to satisfy himself as to the maintenance condition and lubrication of the hoist ropes. Concurrent with periodic surveys he is to carry out a complete *in situ* visual examination for signs of corrosion, wear or broken wires:

- (a) In general, wire ropes are to be renewed where there are 5 per cent or more of broken, worn or corroded wires in any length of ten rope diameters. However, reference may be made to a recognized national standard in determining discard criteria.
- (b) Each year a minimum number of ropes are to be removed from installations as follows:

Up to 6 hoist units	: 1 rope
6 to 20 hoist units	: 2 ropes
More than 20 hoist units	: 4 ropes

A test to destruction is to be carried out on a sample length selected by the Surveyor from each of the ropes being replaced. Should the test piece fail at breaking loads more than 10 per cent below the minimum required values, consideration will be given to the need to select for test and replacement some or all of the remaining ropes.

- (c) It is the intention that all ropes are replaced in sequence at a rate determined by wear, chemical attack, corrosion or other forms of deterioration associated with the particular installation. For small installations this will result in a replacement cycle of about 5 years. Proposals for the replacement cycle for large installations to exceed 10 years will be specially considered in the light of the test results obtained.

4.4.4 Where the Annual Survey incorporates the use of non-destructive examination equipment to inspect hoist ropes, the following procedure is to be adopted:

- (a) The accuracy and reliability of the NDE equipment is to be demonstrated to the satisfaction of the Surveyors.
- (b) Field tests are to be carried out to the Surveyor's satisfaction to verify the suitability of the equipment for the particular hoist and rope arrangement and rope speed.
- (c) The annual rope survey is to be as follows:
 - (i) Complete visual inspection of all ropes for signs of broken wires. Particular attention is to be given to the condition of the ropes in way of the rope terminations as these areas are unlikely to be accessible to NDE equipment. See (d) Test A.
 - (ii) NDE of a selected number of ropes using approved equipment operated by skilled personnel. The number of ropes selected for inspection is to be in accordance with 4.4.3(b) but not less than 10 per cent of the total number of ropes in the installation. Ropes are to be tested over their full length and are to be selected in accordance with a planned programme of inspection to ensure an even distribution of ropes, selected on an annual rotation basis. See (d) Test B.
 - (iii) Two years after installation of the ship lift, one rope that has been subjected to NDE is to be selected for a test to destruction to verify the NDE results.

Thereafter, one rope is to be selected for a break test each year. See (d) Test C.

- (d) The results of the tests in 4.4.4(c) will be used to determine, to the satisfaction of the Surveyor, whether rope replacement or further testing is necessary for the particular installation. In general, the following criteria are to be used in determining the adequacy of the ropes to be retained in service:

Test A. The number of broken wires is not to exceed 5 per cent in any length of 10 rope diameters.

Test B. The cross-sectional area is not to be reduced by more than 10 per cent of the original area. Where the loss in area is found to be between 5 and 10 per cent, consideration is to be given to including these ropes in subsequent examinations in addition to ropes selected for normal annual NDE.

Test C. The reduction in breaking strength when the combined effect of metal loss, corrosion pitting and broken wires has been taken into account, is not to exceed 10 per cent of the minimum specified rope breaking strength.

- 4.4.5 The Surveyor is to satisfy himself as to maintenance, condition and lubrication of hoist chains. In general, any length of chain so worn that its mean diameter at its most worn part is reduced by 4 per cent or more from its nominal diameter is to be renewed.

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4.4.6 25 per cent of the upper and lower sheaves, bearings, axles and housings are to be examined, with at least two complete sets of sheaves opened up for examination. All sheaves are to be opened up at least once in the 4-yearly survey cycle. Attention is to be paid to lower blocks in way of drain holes and the attachment of sheave housings to upper and lower supports is to be examined.

4.4.7 Covers on 25 per cent of the hoists are to be removed to allow for the following inspections:

- (a) The tooth alignment of open gears is to be checked.
- (b) Main shaft pillow block bearings are to be opened up.
- (c) Cap screws securing final spur wheels to the drum are to be checked tightened with a torque spanner.
- (d) Primary gears and all open gear shafts and bearings are to be examined.
- (e) The hoist frame and bolting arrangements are to be examined.

4.4.8 Where the transfer system is included in the class notation 25 per cent of the transfer bogies are to be examined.

- (a) Wheels are to be examined for wear and the condition of linkages between bogies is to be checked.
- (b) A random selection of 10 per cent of the axle pins to the bogie wheels is to be withdrawn for inspection for signs of excessive wear and other defects.
- (c) The rails are to be examined for alignment and signs of wear and to verify the adequacy of the locating and locking arrangements.

4.4.9 A complete megger test of all electrical systems is to be carried out and electrical cables are to be examined.

- (a) Breakers, relays and all other mechanical electrical gear are to be examined.
- (b) 25 per cent of electric motors including bearings and magnetic brakes are to be examined.
- (c) All circuit breakers to be tested for overload tripping.
- (d) Air compressors for hoist ratchet and arrangement are to be generally examined together with the air tank.
- (e) The efficiency of all safety devices is to be demonstrated.

4.4.10 At a convenient time close to the Periodical Survey, the Surveyor should attend during a hoist and transfer operation.

4.4.11 It should be noted that timber decking is not a class matter. However, the general condition of timber should be reported.

4.4.12 Any other matter which may have a bearing on the class of the installation is also to be reported.

4.4.13 The requirements for Periodical Surveys for small installations will be considered.

4.5 Classification of installations not built under survey

4.5.1 Where classification is desired for a mechanical lift dock not built under survey, plans and information showing the materials of construction, arrangements and principal scantlings are to be submitted for approval.

4.5.2 A thorough survey of the installation is to be carried out and is to include the following:

- (a) A thorough examination of the steel structure. The scantlings of material present and the extent of any deterioration is to be recorded. Non-destructive testing is to be carried out in accordance with 4.3.3.
- (b) A thorough examination of all the hoist ropes or chains, together with sheaves and winch sets. Ropes or chains are to be renewed as may be required by 4.4.3. The requirements of 4.4.4 are to be applied and the initial extent of renewal is to be agreed with the Surveyor.
- (c) A thorough examination of all the winches and of the electrical and control system in accordance with 4.4.7 and 4.4.9 respectively.

4.5.3 The installation is to be tested in accordance with Section 3.

4.5.4 Where the transfer system is to be included in the class notation, the requirements of 4.4.8 are to be complied with, except that 25 per cent of the axle pins to the bogie wheels are to be withdrawn for inspection.

■ Section 5 Certification requirements

5.1 General

5.1.1 Where LR is requested to issue certification for a mechanical lifting dock but the installation is not to be classed, the procedure given in this Section is to be adopted.

5.1.2 Constructional plans and all necessary particulars are to be submitted for approval before the work is commenced. Any subsequent modifications or additions to the scantlings or arrangements shown on the approved plans are also to be submitted for approval.

5.1.3 New installations are, from the commencement of the work until completion and installation, to be examined by the Surveyors with respect to materials, workmanship and arrangements. Any items not in accordance with the approved plans or other applicable requirements, or any material, workmanship or arrangements found to be unsatisfactory, are to be rectified.

5.1.4 The requirements for weld procedure tests and weld inspection are to be agreed with the Surveyors. In general, however, it is recommended that non-destructive testing of welding to primary members should be carried out as follows:

- (a) All fillet and butt welds in the area of support for sheave housings, transverse butt welds in main girders and similar critical areas.
- (b) 10 per cent of all other fillet and butt welds in primary structural members.

5.1.5 The installation is to be tested in accordance with the requirements of Section 3.

Section

- 1 **Introduction**
- 2 **Cargo and vehicle lifts**
- 3 **Vehicle ramps**
- 4 **Passenger lifts**

■ **Section 1** **Introduction**

1.1 General

1.1.1 The requirements of this Chapter are to be complied with in cases where LR is requested to issue certification for the following installations:

- (a) Cargo and vehicle lifts.
- (b) Vehicle ramps.
- (c) Passenger lifts.

Where requested, the appropriate requirements of (a) and (b) will be applied by LR for the examination of the opening and closing operation for other similar installations such as stern or bow doors.

1.1.2 For classification requirements, particularly with respect to structural and watertight integrity of the ship, reference should be made to the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as the Rules for Ships).

■ **Section 2** **Cargo and vehicle lifts**

2.1 General

2.1.1 This Section applies to cargo and vehicle lifts which are operated whilst the ship is in a harbour or sheltered water environment, and where cargo or vehicles may be stowed on them in their stowed position whilst the ship is at sea, i.e. *Standard Service Category*.

2.1.2 Where the lift is designed to operate in conditions other than those defined in 2.1.1, the design is to be subject to special consideration, i.e. *Specified Service Category*.

2.1.3 The operating and stowed loading conditions are to be clearly specified in all submissions together with hoisting speeds, and braking times.

2.1.4 For the operating condition, the lift is to be considered with respect to the following forces and loads:

- (a) Self-weight of lift.
- (b) Applied loading.
- (c) Dynamic forces due to hoisting/lowering.
- (d) Forces due to static inclination of the ship.

2.1.5 The lift structure and locking mechanism are also to be examined with respect to the stowed condition for the following criteria appropriate to the ship's characteristics:

- (a) Self-weight of lift.
- (b) Applied load due to vehicle or cargo loading.
- (c) Forces due to ship motion and static inclination.
- (d) Weather loading, where appropriate.

2.2 Basic loads

2.2.1 The self-weight load, L_w , is the load imposed on the hoisting mechanism by the weight of the structure and machinery.

2.2.2 The applied load, L_c , is the loading imposed on the lift structure by the cargo or vehicles.

2.2.3 The safe working load (SWL) is the maximum load for which the lift is certified and is equal to the maximum value of L_c .

2.3 Dynamic forces due to hoisting

2.3.1 To take account of acceleration and shock loading the self-weight and applied load are to be multiplied by 1,20.

2.4 Forces due to ship motion

2.4.1 Lifts are to be designed to operate in a harbour or sheltered water environment where there is no significant motion of the ship due to wave action.

2.4.2 For the operational condition, the lift is to be designed to operate safely and efficiently at an angle of heel of the ship of 5°, and an angle of trim of 2°, acting simultaneously. If it is intended to operate a lift at angles differing from these, the lift is to be designed for these angles and the certificate marked accordingly.

2.4.3 In addition to the operating conditions, the lift and its locking mechanisms are also to be designed to withstand the following conditions when stowed:

- (a) Acceleration normal to deck of $\pm 1,0 \text{ g}$
Acceleration parallel to deck in fore and aft directions of $\pm 0,5 \text{ g}$
Static heel of 30°.

- (b) Acceleration normal to deck of $\pm 1,0 \text{ g}$
Accelerations parallel to deck in transverse directions of $\pm 0,5 \text{ g}$
Static heel of 30°.

2.4.4 Alternatively, where the lift is to be fitted to a conventional ship and the ship's characteristics are known, the forces may be calculated for the combination of static and dynamic forces of Ch 3,2.11 for the ship's motions and accelerations obtained from Tables 3.2.2 and 3.2.3 in Chapter 3.

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Section 2

2.5 Design loads

2.5.1 The design loads are to be consistent with the ship's loading manual and are to include the details of the number and spacing of vehicles the lift is designed to accommodate, the type of vehicles, their weight, axle loading, tyre print dimensions, and number and spacing of wheels and supports. Fig. 5.2.1 gives typical loading information. Due account is to be taken of asymmetric loading where applicable.

2.5.2 In addition to vehicle loading, the lift is to be considered with respect to uniform deck loading (UDL) appropriate to the deck or decks at which it is stowed and is to comply with the appropriate requirements of Pt 3, Ch 3 and Ch 11 of LR's Rules for Ships. Similarly, where the lift forms part of the ship's watertight structure, it is to comply with these requirements as appropriate.

2.6 Load combinations

2.6.1 The lift is to be considered with respect to design loads resulting from the following conditions:

- (a) Case 1 Operating condition.
- (b) Case 2 Stowed condition.
- (c) Case 3 Test load condition.

2.6.2 **Case 1.** The lift is to be considered with respect to the self-weight and applied load multiplied by a dynamic factor of 1,20, together with the horizontal forces as defined in 2.4.2. This is represented by the following expression:

$$1,2(L_w + L_c) + L_{h1} + L_{h2}$$

where

- L_w = self-weight load
- L_c = applied load
- L_{h1} = factored load due to 5° heel
- L_{h2} = factored load due to 2° trim.

2.6.3 **Case 2.** The lift is to be considered with respect to the forces resulting from the accelerations due to ship motion, together with the forces due to consideration of static inclination as defined in 2.4.3 or 2.4.4, together with weather forces appropriate to its stowed position.

2.6.4 **Case 3.** The lift is to be considered with respect to forces due to the self-weight plus the test load, L_t , multiplied by a dynamic factor of 1,20. This case is represented by the following expression:

$$1,2(L_w + L_t)$$

where

- L_t = SWL x proof load factor obtained from Ch 9,1.9.

2.7 Allowable stress – Elastic failure

2.7.1 The allowable stress, σ_a , is to be taken as the failure stress of the component concerned multiplied by a stress factor, F , which depends on the load case considered. The allowable stress is given by the general expression:

$$\sigma_a = F\sigma$$

where

$$\sigma_a = \text{allowable stress, in N/mm}^2$$

$$F = \text{stress factor}$$

$$\sigma = \text{failure stress, in N/mm}^2.$$

2.7.2 The allowable stress factor, F , for steel in which

$$\frac{\sigma_y}{\sigma_u} \leq 0,7, \text{ is to be as given in Table 5.2.1:}$$

where

$$\sigma_y = \text{yield stress of the material stress, in N/mm}^2$$

$$\sigma_u = \text{ultimate tensile strength of the material, in N/mm}^2.$$

Table 5.2.1 Stress factor, F

Load case	Case 1	Case 2	Case 3
Stress factor, F	0,60	0,75	0,85

NOTE
Where the lift forms part of the hull structure, the scantlings are to comply with the requirements of the Rules for Ships.

2.7.3 For steel with $\frac{\sigma_y}{\sigma_u} > 0,7$, the allowable stress is to

be derived from the following expression:

$$\sigma_a = 0,41F(\sigma_u + \sigma_y)$$

$$\tau_a = 0,24F(\sigma_u + \sigma_y)$$

2.7.4 The failure stresses for elastic failure are given in Table 5.2.2.

Table 5.2.2 Failure stress

Mode of failure	Symbols	Failure stress
Tension	σ_t	$1,0\sigma_y$
Compression	σ_c	$1,0\sigma_y$
Shear	τ	$0,58\sigma_y$
Bearing	σ_{br}	$1,0\sigma_y$

2.7.5 For components subject to combined stresses, the following allowable stress criteria are to be met:

- (a) $\sigma_{xx} < F\sigma_t$
- (b) $\sigma_{yy} < F\sigma_t$
- (c) $\tau_o < F\tau$
- (d) $(\sigma_{xx}^2 + \sigma_{yy}^2 - \sigma_{xx}\sigma_{yy} + 3\tau_o^2)^{1/2} < 1,1F\sigma_t$

where

$$\sigma_{xx} = \text{applied direct stress in x direction, in N/mm}^2$$

$$\sigma_{yy} = \text{applied direct stress in y direction, in N/mm}^2$$

$$\tau_o = \text{applied shear stress, in N/mm}^2.$$

2.8 Allowable stress – Plate buckling failure

2.8.1 The allowable stress is to be taken as the critical buckling stress of the component concerned multiplied by the stress factor, F , as defined in Table 5.2.1. The critical buckling stress is obtained by reference to Ch 3,2.22.

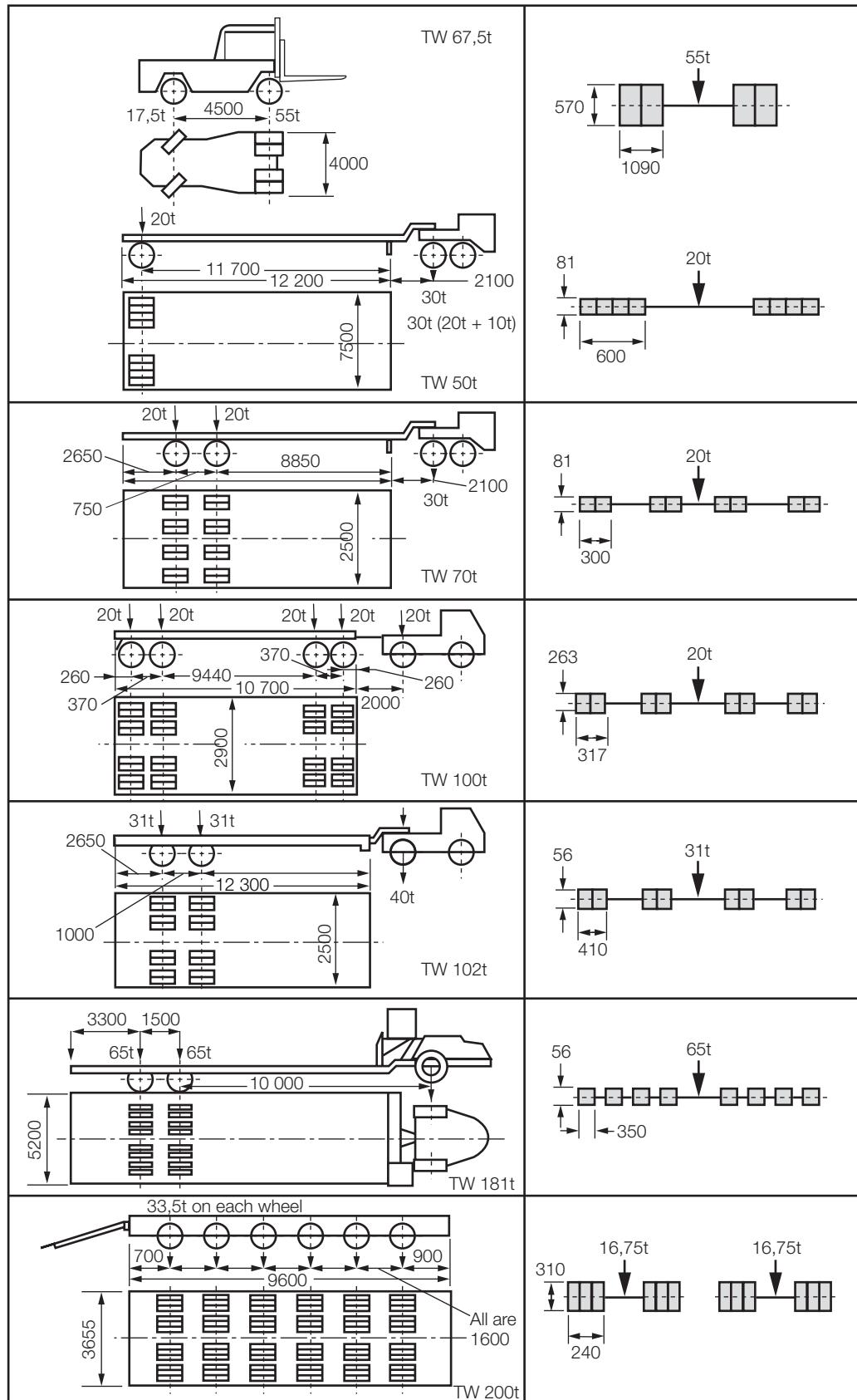


Fig. 5.2.1 Typical loading data

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Chapter 5

Section 2

2.9 Required deck plating thickness

2.9.1 The deck plating thickness, t , is to be not less than:

$$t = 4,6 \sqrt{A P_w + 1,5} \text{ mm}$$

where

A = stress factor obtained from Fig. 5.2.2 for the tyre print and plate dimensions defined in the figure

P_w = load, in tonnes, on the tyre print. For close-spaced wheels, the shaded area shown in Fig. 5.2.2, may be taken as the combined wheel print.

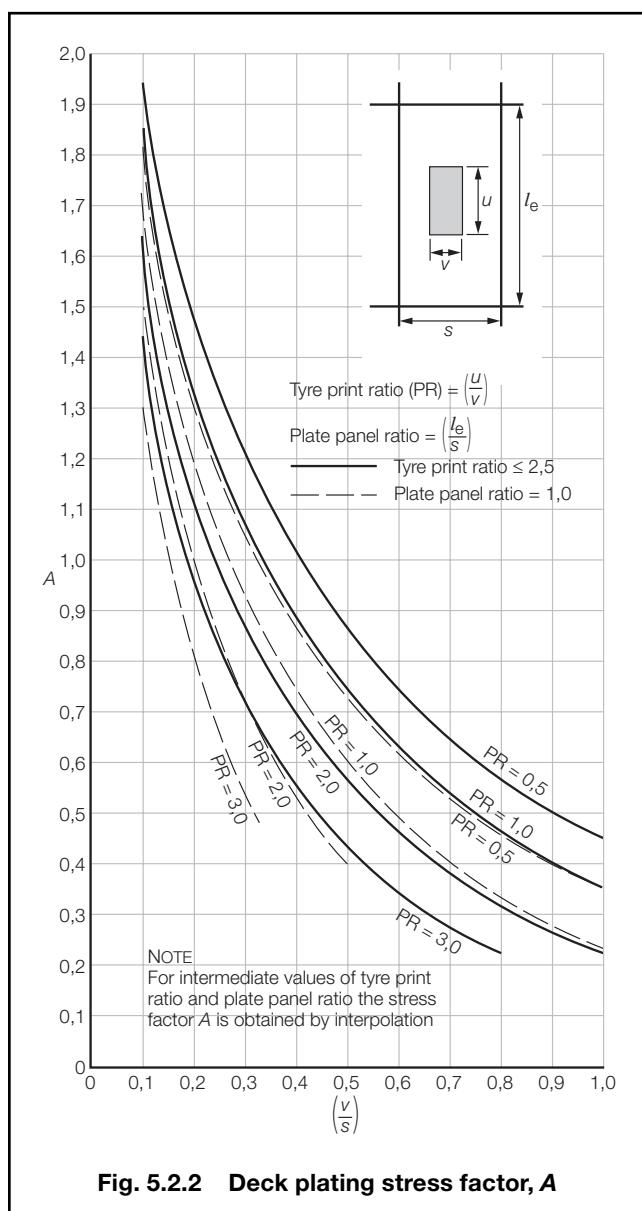


Fig. 5.2.2 Deck plating stress factor, A

2.10 Deflection criteria

2.10.1 The deflection of the lift structure or of any individual member with respect to Case 1 and 2, see 2.6.2 and 2.6.3, is to be limited to:

$$\frac{l}{400} \text{ mm}$$

where

l = distance between supports, in mm.

2.10.2 Where applicable, the deflection is to be limited to ensure the watertight integrity of the ship is maintained.

2.11 Guide rails

2.11.1 Arrangements are to be provided to restrict horizontal movements of the lift during operation by guide rails, or other means.

2.11.2 Where guide rails are fitted, they are to be such that the maximum deflection, resulting from horizontal components of load, is not greater than 6,0 mm. The working clearance between the lift and guide rail is to be such as to allow free vertical movement of the lift.

2.12 Stowage locks

2.12.1 Stowage locks are to be provided to resist the vertical, forward/aft and lateral loads as defined in 2.6.3. Arrangements are to be such that the locks do not work loose and impair the watertight integrity of the ship.

2.13 Hoisting arrangements

2.13.1 Where chains are used as part of the hoisting arrangement, they are to have a minimum safety factor of 4,0.

2.13.2 Where wire ropes are used as part of the hoisting arrangement, they are to have a safety factor given by:

$$SF = \frac{10^4}{8,85L + 1910}$$

but not less than 4,0 nor greater than 5,0.

where

SF = minimum safety factor required

L = safe working load of lift

This is represented graphically in Fig. 3.2.11 in Chapter 3.

2.14 Materials

2.14.1 Materials are to comply with the requirements of Chapter 8.

2.14.2 Where the lift is a classification item, the material is to comply with Ch 8,1.1 and the grade of steel selected in accordance with Table 3.5.2 in Chapter 3.

2.14.3 Where the lift is subject to certification only, the material is to comply with Ch 8,2. The selected steel grade is to provide adequate assurance against brittle fracture taking into account the material tensile strength and thickness and the environment in which the lift is designed to operate and, in general, is to comply with the Charpy test requirements given in Table 3.2.17 in Chapter 3.

■ Section 3

Vehicle ramps

3.1 General

3.1.1 This Section applies to moveable vehicle ramps installed on ships where the loading or unloading operation is carried out in a harbour or sheltered water, i.e. *Standard Service Category*.

3.1.2 Where the ramp is designed to operate in conditions other than those defined in 3.1.1, the design will be specially considered, i.e. *Specified Service Category*.

3.1.3 The loaded and stowed conditions must be clearly specified in all submissions, together with hoisting speeds, braking times and operating angles for the intermediate positions of the ramp.

3.1.4 For the loaded condition, the ramp is to be considered for the worst possible combination of angles and support arrangement (supported by the quay and/or its hoisting mechanism) with respect to the following forces:

- (a) Self-weight.
- (b) Applied load.
- (c) Dynamic forces due to vehicle movement.

3.1.5 For raising and slewing manoeuvres, the ramp is to be considered with respect to the following forces:

- (a) Self-weight.
- (b) Applied load, where appropriate.
- (c) Dynamic forces due to hoisting/slewing.
- (d) Forces due to ship's static inclinations.

3.1.6 For the stowed condition, the ramp and its locking mechanism are to be considered with respect to the following forces:

- (a) Self-weight.
- (b) Applied load, where appropriate.
- (c) Forces due to the ship motion and static inclination.
- (d) Weather loading as appropriate.

3.2 Basic loads

3.2.1 The self-weight load, L_w , is to be taken as the weight of the ramp and is to be multiplied by 1,2 to take account of the dynamic forces due to manoeuvring the ramp.

3.2.2 The applied load, L_c , is the static load on the ramp due to cargo or vehicles and is to be multiplied by 1,1 to take account of vehicle movement.

3.2.3 When the ramp is manoeuvred whilst loaded, both L_w and L_c are to be multiplied by 1,2.

3.3 Forces due to ship motion

3.3.1 Ramps are to be designed to operate in a harbour or sheltered water environment where there is no significant motion of the ship due to wave actions.

3.3.2 For both the lowered and manoeuvring conditions the ramp is to be designed to operate safely and efficiently at an angle of heel of 5°, and an angle of trim of 2° acting simultaneously.

3.3.3 The slope of the ramp is not to exceed 1 in 10 and where the ramp is designed for ship to shore use, this angle is to include the effects of heel and trim defined in 3.3.2. Where a ramp is designed to operate at a greater slope, it will be subject to special consideration.

3.3.4 The ramp and locking mechanism are to be designed to withstand the following conditions when the ramp is in its stowed position:

- (a) Acceleration normal to deck of $\pm 1,0\ g$
Acceleration parallel to deck in fore and aft direction of $\pm 0,5\ g$
Static heel of 30°.
- (b) Acceleration normal to deck of $\pm 1,0\ g$
Acceleration parallel to deck in transverse direction of $\pm 0,5\ g$
Static heel of 30°.

3.3.5 Alternatively, where the ramp is to be fitted to a conventional ship and the ship's characteristics are known, the forces may be calculated for the combination of static and dynamic forces of Ch 3,2.11 for the ship's motions and accelerations obtained from Tables 3.2.2 and 3.2.3 in Chapter 3.

3.4 Design loads

3.4.1 The design loads are to be consistent with the ship's loading manual and are to include the details of the number and spacing of vehicles the ramp is designed to carry, the type of vehicles, their weight, axle loading, tyre print dimensions, and number and spacing of wheels and supports. Fig. 5.2.1 gives typical ramp loading information.

3.4.2 In addition to vehicle loading, where a ramp in its stowed position forms part of a deck, it is to be considered with respect to the uniform deck loading (UDL) appropriate to that deck and is to comply with the appropriate requirements of Pt 3, Ch 3, Pt 3, Ch 11 and Pt 4, Ch 2 of LR's Rules for Ships. Similarly, where the ramp forms part of the ship's watertight structure it is to comply with these requirements as appropriate.

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Chapter 5

Sections 3 & 4

3.5 Load combinations

3.5.1 The ramp is to be considered with respect to design loads resulting from the following conditions:

- Case 1 Lowered condition.
- Case 2 Stowed condition.
- Case 3 Manoeuvring condition.

Case 1. The ramp is to be considered with respect to self-weight plus the applied load multiplied by 1,1, together with the horizontal forces as defined in 3.3.2 and 3.3.3. This is represented by the following expression:

$$L_w + 1,1L_c + L_{h1} + L_{h2} + L_{h3}$$

where

- L_w = self-weight load
- L_c = applied load
- L_{h1} = load due to 5° heel
- L_{h2} = load due to 2° trim
- L_{h3} = load due to ramp angle.

3.5.2 **Case 2.** The ramp and locking mechanism are to be considered with respect to the forces acting on the self-weight and applied load as appropriate resulting from accelerations due to the ship's motions and static inclination together with weather forces appropriate to the stowed position.

3.5.3 **Case 3.** The ramp is to be considered with respect to its self-weight and applied load as appropriate multiplied by 1,20, together with the horizontal forces defined in 3.3.2.

(a) For ramps which are unloaded during manoeuvring, this is represented by the following expression:

$$1,2L_w + L_{h1} + L_{h2}$$

(b) For ramps which are loaded during manoeuvring, this is represented by the following expression:

$$1,2(L_w + L_c) + L_{h1} + L_{h2}$$

3.6 Allowable stresses

3.6.1 The allowable stresses are as defined in 2.7. to 2.9 inclusive.

3.7 Deflection criteria

3.7.1 The deflection of the ramp between supports with respect to Cases 1 and 2 is to be limited to that given by the following expression:

$$\frac{l}{400} \text{ mm}$$

where

l = distance between supports, in mm.

3.7.2 Where applicable, the deflection in the stowed condition is to be limited to ensure the watertight integrity of the ship is maintained.

3.8 Stowage locks

3.8.1 Stowage locks are to be provided to resist the vertical, forward/aft and lateral forces resulting from consideration of load Case 2, see 3.5.2 and to maintain the watertight integrity of the ship.

3.9 Hoisting and slewing arrangements

3.9.1 Where chains are used as part of the hoisting or slewing arrangement, they are to have a minimum safety factor of 4,0.

3.9.2 Where wire ropes are used as part of the hoisting or slewing arrangement, they are to have a safety factor given by:

$$SF = \frac{10^4}{8,85L + 1910}$$

but not less than 4,0 nor greater than 5,0

where

SF = minimum safety factor required

L = weight of the ramp (for ramps which are unloaded during manoeuvring) or the SWL (for ramps which are loaded during manoeuvring.)

This is represented graphically in Fig. 3.2.11 in Chapter 3.

3.10 Materials

3.10.1 Materials are to comply with the requirements of Chapter 8.

3.10.2 Where the ramp is a classification item, the material is to comply with Ch 8,1.1 and the grade of steel selected in accordance with Table 3.5.2 in Chapter 3.

3.10.3 Where the ramp is subject to certification, the material is to comply with Ch 8,1.2. The selected steel grade is to provide adequate assurance against brittle fracture taking into account the material tensile strength and thickness and the environment in which the ramp is designed to operate and, in general, is to comply with Charpy test requirements given in Table 3.2.17 in Chapter 3.

■ Section 4 Passenger lifts

4.1 General

4.1.1 This Section applies to electric and hydraulic powered lifts permanently installed in ships and employing an enclosed car suspended by ropes or supported by hydraulic jacks and running between rigid guides for the transfer of persons, or persons and goods, between the decks. The rated speed is not to exceed 1,0 m/s. Lifts designed for a higher rated speed will be specially considered.

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Section 4

4.1.2 The lift is to comply with the requirements of a recognized national or international standard, e.g. EN81, any requirements of the National Authority of the country of registration and the requirements contained in this Section.

4.1.3 The rated load, minimum stopping distance, buffer stroke, type of hoisting drive, type of safety gear and buffer are to be clearly specified in all lift submissions.

4.1.4 The lift is to be designed such that it can be stowed, either manually or automatically, in the event of the specified operational conditions being exceeded.

4.1.5 For the operating conditions, the lift is to be considered with respect to the following forces:

- (a) Self-weight of car.
- (b) Rated load.
- (c) Dynamic forces due to lift motion.
- (d) Forces due to ship motion and static inclination.

4.1.6 For the stowed condition, the lift is to be considered with respect to the following forces:

- (a) Self-weight of car.
- (b) Forces due to ship motion and static inclination.

4.2 Basic loads

4.2.1 The self-weight load, L_w , is the load imposed on the hoisting mechanism by the weight of the permanent components of the lift car structure and machinery.

4.2.2 The rated load, L_c , is the load imposed on the lift car by the passengers and is to be not less than that obtained from Table 5.4.1.

4.2.3 Where lifts are mainly intended to carry goods which are generally accompanied by people, the design is to take into account the load to be carried and the weight of the handling device which may enter the car in addition to the requirements of Table 5.4.1.

4.3 Dynamic forces resulting from operation of safety device or car striking buffers

4.3.1 The dynamic forces due to the operation of the safety devices or the car striking the buffers are to be taken into account by multiplying the self-weight and applied load by a factor, F_s , which is calculated using the following expression:

$$F_s = 2 + \frac{0,135V^2}{S}$$

where

V = rated speed, in m/s

S = minimum stopping distance or buffer stroke, whichever is the lesser.

4.3.2 The rated speed, minimum stopping distance and buffer stroke are to be obtained from the lift specification to which the lift is constructed. Table 5.4.2 gives typical values of governor tripping speed and stopping distances and Fig. 5.4.1 typical buffer strokes.

Table 5.4.1 Rated load

Rated load, in kg	Maximum available car area, in m ²	Maximum number of passengers
100	0,40	1
180	0,50	2
225	0,70	3
300	0,90	4
375	1,10	5
400	1,17	5
450	1,30	6
525	1,45	7
600	1,60	8
630	1,66	8
675	1,75	9
750	1,90	10
800	2,00	10
825	2,05	11
900	2,20	12

NOTES

1. For intermediate loads, the area is determined by linear interpolation.
2. The maximum number of persons carried is given by:

$$\frac{L_c}{75}$$
 rounded down to the nearest whole number where, L_c is the rated load.
3. If the rated load exceeds by more than 15 per cent that indicated in the table for maximum available car area, the maximum number of passengers permitted shall correspond to that area.
4. Recesses and extensions, even of height less than 1 m, whether protected or not by separating doors, are only permitted if their area is taken into account in the calculation of the maximum available car area.

Table 5.4.2 Governor tripping speeds and stopping distances

Rated speed, in m/s	Governor tripping speed, in m/s	Stopping distances	
		Minimum, in metres	Maximum, in metres
0 to 0,62	0,88	0,15	0,38
0,75	1,05	0,15	0,41
1,00	1,40	0,23	0,58

4.4 Forces due to ship motion

4.4.1 Passenger lifts, their associated machinery and structure are to be designed to operate at sea with respect to the following conditions:

- (a) Roll: $\pm 10^\circ$, with 10 second period.
- (b) Pitch: $\pm 7,5^\circ$, with 7 second period.

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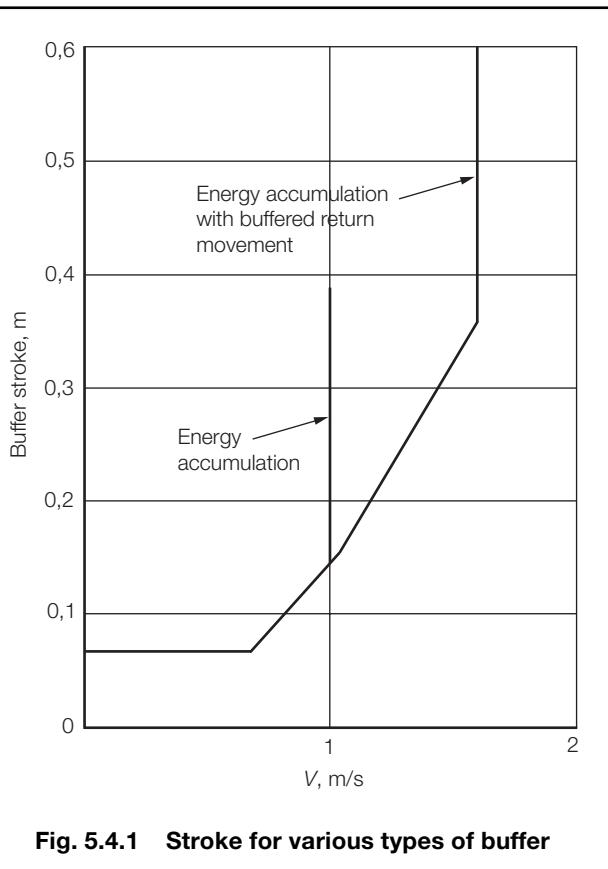


Fig. 5.4.1 Stroke for various types of buffer

4.4.2 In addition to the operational conditions the lift, associated machinery and structure are to be designed to withstand the forces resulting from consideration of the following conditions when in its stowed condition:

- Roll: $\pm 22,5^\circ$, with 10 second period.
- Pitch: $\pm 7,5^\circ$, with 7 second period.
- Heave: Amplitude = $0,0125L$ with 10 second period where, L , is the Rule length of the ship (see Pt 3, Ch 1 of the Rules for Ships).

4.5 Load combination

4.5.1 The lift and its associated mechanism and structure are to be considered with respect to design loads resulting from the following conditions:

- Case 1.** The lift is to be considered with respect to the dead load and live load multiplied by the factor, F_s , together with the horizontal forces resulting from the condition defined in 4.4.1. This is represented by the following expression:

$$(L_w + L_c) F_s + L_{h1} + L_{h2}$$

where

L_w = self-weight

= rated load

F_s = the dynamic factor due to safety devices operating or car striking buffers

L_{h1} = horizontal force due to roll

L_{h2} = horizontal force due to pitch.

- Case 2.** The lift (self-weight only) is to be considered with respect to the forces resulting from the accelerations due to the ship's motion as defined in 4.4.2.

4.6 Allowable stresses

4.6.1 The stress factor and allowable stresses are to be in accordance with 2.7 to 2.10.

4.7 Deflection criteria

4.7.1 The deflection of the car structural members is not to exceed:

$$\frac{l}{600} \text{ mm}$$

4.7.2 The deflection of the guide rails is not to exceed:

$$\frac{l}{400} \text{ mm}$$

or 3,0 mm, whichever is the lesser

where

l = distance between supports, in mm.

4.7.3 The car walls or doors in their closed position are to be able to resist without permanent deformation or elastic deformation greater than 15 mm a force of 300 N evenly distributed over a circular or square area of 500 mm² applied parallel to the deck from inside towards the outside of the car. The doors are to be capable of operating normally after being subjected to this load.

4.7.4 The car roof is to withstand without permanent deformation a force of 2000 N applied at any position and normal to the deck.

4.8 Guides

4.8.1 At least two steel guides are to be installed and the surface finish is to be sufficiently smooth to allow free running of the car or counterweight.

4.8.2 The guides are to be designed to resist forces resulting from application of the safety devices by multiplying the self-weight and applied load by a factor obtained from Table 5.4.3.

Table 5.4.3 Factors for guide designs

Type of safety device	Factor, F_s
Instantaneous safety device, except captive roller type	2,5
Captive roller type safety device	1,4
Progressive safety device	1,0

4.8.3 The allowable stress in the guides is to be calculated in accordance with the method described in Ch 3,2.19.

4.9 Safety gear

4.9.1 The car and counterweight are to be provided with safety gear capable of operating only in a downward direction by gripping the guides. It should be capable of stopping the fully laden car or counterweight, at the tripping speed of the overspeed governor, even if the suspension device breaks. The safety gear is to be tripped by an overspeed governor, but the counter-weight may be tripped by failure of the suspension gear or by a safety rope.

4.9.2 The safety gear may be of the instantaneous type with buffered effect or of the instantaneous type where the rated speed is not in excess of 0,63 m/s.

4.9.3 The counterweight safety gear may be of the instantaneous type.

4.9.4 The jaws of safety devices are not to be used as guide shoes.

4.10 Overspeed governors

4.10.1 Tripping of the overspeed governors is to occur at a speed of at least 115 per cent of the rated speed and not more than the following:

- (a) 0,8 m/s for instantaneous safety gears except for the captive roller type.
- (b) 1,0 m/s for safety gears of the captive roller type.
- (c) 1,5 m/s for instantaneous safety gear with buffered effect.

4.10.2 The tripping speed of an overspeed governor for a counterweight safety gear is to be higher than that for the car safety gear but is not to exceed it by more than 10 per cent.

4.10.3 The force exerted by the overspeed governor when tripped is to be not less than the greater of:

- (a) 300 N; or
- (b) twice the force necessary to engage the safety gear.

4.10.4 The breaking load of the overspeed governor operating rope is to have a safety factor of 8,0 with respect to the force required to operate the safety gear. The rope is to be not less than 6,0 mm diameter and the ratio of the bottom of the sheave groove diameter to rope diameter is to be not less than 30 to 1.

4.11 Buffers

4.11.1 The car and counterweight are to be provided with buffers at their bottom limit of travel. If the buffers travel with a cage or counterweight they are to strike against a pedestal at least 0,5 m high at the end of the travel.

4.11.2 Where energy accumulation type buffers are used, the total possible stroke of the buffers shall be at least equal to twice the gravity stopping distance corresponding to 115 per cent of the rated speed, i.e.:

$S = 0,135V^2$ but not less than 0,065 m
where

S = stroke, in metres

V = rated speed, in m/s

Buffers are to be designed for the above stroke, under a static load of 4,0 times the self-weight of the car plus its rated load or 4,0 times the weight of the counterweight as appropriate.

4.11.3 With the rated load in the car, the average deceleration due to the buffers acting on a free falling car is not to exceed 1,0 g and the maximum deceleration is not to exceed 2,5 g .

4.12 Hoisting arrangements

4.12.1 The hoisting arrangements may consist of:

- (a) Traction drive using sheaves and ropes; or
- (b) positive drive, if the rated speed is not greater than 0,64 m/s, consisting of:
 - (i) Drum and rope without counterweight; or
 - (ii) sprocket and chain.

4.12.2 The ratio of sheave groove diameter or drum to rope diameter is to be not less than 40 to 1. Where drum drive is used, the drum is to be grooved and the fleet angle of the rope in relation to the groove is not to be greater than 4° either side of the groove axis.

4.12.3 Not more than one layer of rope is to be wound on the drum and when the car rests on its fully compressed buffers one and a half turns of rope are to remain in the grooves.

4.12.4 The safety factors of suspension ropes, defined as the ratio of minimum breaking load of the rope to the maximum load on the rope when the car is at its lowest level and subjected to its rated load, are to be not less than:

- (a) 12 to 1 in the case of traction drive with three ropes or more.
- (b) 16 to 1 in the case of traction drive with two ropes.
- (c) 12 to 1 in the case of drum drive.

4.12.5 A device is to be fitted at one end of the hoisting arrangement to equalize the tension in the ropes or chains.

4.12.6 Where compensating ropes are used, the ratio between the bottom of sheave groove diameter and diameter of the rope is to be not less than 30 to 1.

4.13 Lift trunk and motor room

4.13.1 All lift trunks and machinery spaces are to be completely enclosed, suitably ventilated, and constructed to give fire protection in compliance with the requirements of SOLAS 1974.

4.13.2 Clearances around the car are also to be guarded or arranged to preclude the possibility of personnel falling between the car and trunk.

Lifts and Ramps

Chapter 5

Section 4

4.13.3 Only pipes and cables belonging to the lift may be installed in the trunk and travelling cables are to be protected by an internally smooth metal trough which is to be provided with a slot having rounded edges to allow free passage of the cables leaving the lift car and be of sufficient width to allow passage of the free hanging loop of the travelling cable.

4.13.4 Where two or more lifts are fitted into one trunk, each car and its associated counterweight is to be separated by means of sheet steel over the full height of the trunk.

4.13.5 The lift trunk is not to be part of the ship's ventilation ducting but is to be ventilated by an independent system.

4.13.6 The trunk entrances are to be located to prevent the ingress of water or cargo into the trunk, and the deck areas at entrances are to be non-slip and of approved material which will not readily ignite.

4.13.7 Where the lift is for crew, the headroom of the trunk (the space above the car roof when the car is in its highest position) is to incorporate an escape hatch of 0,5 x 0,5 m minimum dimensions.

4.14 Lift car and counterweight

4.14.1 The car is to be constructed of steel or equivalent non-flammable material, have a non-slip floor and be provided with at least one handrail where access for persons is clearly available. A load plate is to be prominently displayed specifying the safe working load in persons and kilogrammes.

4.14.2 The car entrances are to be provided with doors of an imperforate type fitted with devices to prevent untimely opening and slamming. The clearance between the car and car door is to be not more than 6,0 mm.

4.14.3 Power operated doors are to be of the centre opening balanced type and manual doors of the two panel centre opening type or concertina or telescopic type opening from one side only. Manual single sliding entrances of the concertina or telescopic type are to be fitted with devices to prevent slamming.

4.14.4 The car and counterweight are to be guided over their full travel, including overtravel and an independent guidance medium to limit car movement in the event of casting failure is to be provided where cast iron shoes or guide shoes contained in cast iron housings are used.

4.14.5 Counterweights are to be constructed of steel or equivalent material and filler weights are to be securely clamped in position within steel frames. Concrete filler weights are not permitted. A suitable device is to be fitted to stop and support the counterweight in the event of rope failure.

4.14.6 Traction drive lifts are to incorporate a device to stop and support the car if:

- (a) When a start is initiated the lift machine does not rotate.
- (b) The car or counterweight is stopped in downwards movement by an obstruction which causes the ropes to slip on the driving pulley.

4.14.7 The device is to function in a time not greater than the lesser of the following values:

- (a) 45 s.
- (b) Time for the car to travel the full distance, plus 10 s, with a minimum of 20 s if the full travel time is less than 10 s.

4.14.8 The device is not to affect either the inspection or electrical recall operation.

4.15 Landing doors

4.15.1 Steel doors are to be fitted at all entrance stations. When closed, the doors are to provide fire resistance at least as effective as the trunk to which they are fitted.

4.15.2 Power operated doors are to be of the centre opening balanced type and manual doors of the two panel centre opening type or concertina or telescopic type opening from one side only. Manual single sliding entrances of the concertina or telescopic type are to be fitted with devices to prevent slamming.

4.16 Emergency means of escape

4.16.1 For crew lifts, the trunk is to be fitted with a ladder over its entire length leading to the escape hatch in the headroom.

4.16.2 For lifts intended solely for passengers, a suitable ladder is to be provided to give access to the lift car roof from a landing door and either the same or another provided to give access into the car from the emergency opening in the car roof. These ladders are to be kept in a watchkeeping room or room accessible to competent persons.

4.16.3 A trap door in the roof of the lift car with suitable access to it from the inside is to be provided. Where the lift is solely for passengers, the trap door is to be fitted with a mechanical lock which can only be operated from the outside. Where the lift is solely for crew the trap door is to be fitted with a mechanical lock which can be operated from inside and outside the car.

4.16.4 For crew lifts, an escape hatch is to be provided in the headroom of the trunk. Opening the hatch from the outside is only to be possible by means of a special key which is to be kept in a box immediately by the hatch.

4.16.5 Notices in English, other languages and pictographs as necessary, describing the escape routine are to be fixed in the following locations:

- (a) Inside the car.
- (b) On the car roof.
- (c) Inside the trunk, adjacent to every exit.

Fittings, Loose Gear and Ropes

Chapter 6

Sections 1 & 2

Section

- 1 **General**
- 2 **Fittings**
- 3 **Blocks**
- 4 **Spreaders and lifting beams**
- 5 **Loose gear**
- 6 **Steel wire ropes**
- 7 **Fibre ropes**

■ Section 1 **General**

1.1 Application

1.1.1 Fittings, loose gear and ropes are, in general, to be manufactured in accordance with international or recognized national standards.

1.1.2 Tables of standard dimensions for certain fittings and items of loose gear are given in this Chapter. These dimensions are nominal and appropriate allowance is to be made for working tolerances. The symbols used are shown on sketches of typical designs of these items which are given here for illustration only.

1.1.3 Tables of minimum breaking loads for a range of steel wire ropes and fibre ropes are also given.

1.1.4 Alternative designs and designs for items not covered by appropriate standards will be considered on the general basis of the requirements of this Chapter.

1.1.5 The safe working load (SWL) of any item is to be not less than that required by the appropriate requirements of this Code for the position occupied by the item in the rig.

1.2 Materials and construction

1.2.1 Materials are to comply with the requirements of Chapter 8.

1.2.2 Steel for bearing brackets and other items welded to the ship's structure (including to the masts and derrick posts), is generally, to comply with the requirements of the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials). The grade of steel is to be as follows:

Thickness, in mm	$t \leq 20,5$	$20,5 < t \leq 25,5$	$25,5 < t \leq 40$	$40 < t$
Grade	A/AH	B/AH	D/DH	E/EH

1.2.3 Steel for other items is to comply with LR's requirements as in 1.2.2 or with an appropriate national standard approved by LR as suitable for the intended purpose.

1.2.4 Where items are flame cut from solid material they are subsequently to be machined or forged and machined as necessary and the faces are to be dressed to give a smooth finish. Attention is to be paid to the fibre direction of the parent plate or billet.

1.2.5 Steel castings and forgings are to be normalized or otherwise heat treated at a temperature and according to a method appropriate to the material and size of the item. Where fabricated items require to be heat treated, this is to be done after completion of all welding. The heat treatment is to be carried out in a properly constructed furnace with adequate temperature control.

1.2.6 Attention is drawn to the undesirability of including in any one assembly items made of materials requiring different heat treatments.

1.2.7 Cast, forged and fabricated items are to be so designed and constructed as to minimize stress concentrations. Fabricated items are to be designed to ensure good penetration of welds and to provide adequate accessibility for non-destructive examination.

1.2.8 All bearing surfaces are to be machined to ensure a smooth finish and good fit. Adequate and accessible means of lubrication are to be provided.

1.2.9 Plain or bushed bearings are to be designed so that the mean pressure based on the projected area of the bearing does not exceed the values given in the appropriate Sections of this Chapter. Where roller, ball or similar bearings are fitted, the loading is not to exceed the value recommended by the manufacturer.

1.3 Testing and certification

1.3.1 The requirements for testing of finished equipment are given in Chapter 9.

1.3.2 The requirements for certification are given in Chapter 10.

■ Section 2 **Fittings**

2.1 Gooseneck and derrick heel assemblies

2.1.1 The safe working load of the gooseneck and derrick heel assembly is to be taken as the least of the values determined separately for the gooseneck pin, the derrick heel lugs and the derrick heel crosspin. Standard dimensions for these items and for the gooseneck bearing bracket, with corresponding safe working loads, are given in Tables 6.2.1, 6.2.2 and 6.2.3 and the items are illustrated in Figs. 6.2.1, 6.2.2 and 6.2.3.

Fittings, Loose Gear and Ropes**Chapter 6**

Section 2

Table 6.2.1 Dimensions of gooseneck pins

Boom axial thrust, in tonnes	Straight pins		Cranked pins		e	d ₂	r	t
	d ₁	l ₁	d ₁	l ₁				
1,6	50	60	—	—	—	24	25	26
2,0	50	60	—	—	—	26	25	28
2,5	60	60	55	60	35	29	30	30
3,2	70	85	60	65	38	32	35	33
4,0	70	70	65	70	40	35	35	36
5,0	80	85	70	80	46	41	40	40
6,3	90	100	80	85	49	44	45	45
8,0	100	105	90	90	52	47	50	50
10,0	110	120	100	100	58	54	55	57
12,5	120	125	110	105	61	58	60	64
16,0	140	150	120	110	64	67	70	73
20,0	155	170	130	115	67	75	75	82
25,0	170	200	140	125	72	79	80	92
32,0	190	210	155	140	78	83	85	102
40,0	190	220	170	155	85	93	95	112
50,0	200	220	—	—	—	103	100	124
63,0	225	245	—	—	—	113	113	140
80,0	250	275	—	—	—	129	125	150
100,0	275	290	—	—	—	144	138	160

NOTES

1. All dimensions are given in millimetres and are illustrated in Fig. 6.2.1.
2. Straight gooseneck pins for axial thrusts exceeding 20 t are generally tapered, see 2.1.3.

Table 6.2.2 Dimensions of derrick heel assemblies

Boom axial thrust, in tonnes	a	b	c	r	t	d ₂	d crosspin
1,6	32	80	28	25	16	24	22
2,0	35	90	30	28	16	26	24
2,5	45	107	32	30	22	29	27
3,2	50	112	35	32	22	32	30
4,0	50	120	38	35	25	35	33
5,0	55	135	42	42	25	41	39
6,3	60	145	47	45	32	44	42
8,0	65	153	53	48	32	47	45
10,0	70	173	60	55	40	54	52
12,5	75	188	67	60	40	58	56
16,0	85	208	76	68	45	67	64
20,0	95	235	85	75	50	75	72
25,0	100	260	95	80	60	79	76
32,0	105	270	105	85	70	83	80
40,0	115	300	115	95	70	93	90
50,0	125	325	127	105	80	103	100
63,0	135	340	144	115	80	113	110
80,0	160	350	154	130	100	129	125
100,0	175	370	164	145	100	144	140

NOTES

1. All dimensions are given in millimetres and are illustrated in Fig. 6.2.2.
2. Values of a and b may be adjusted for other forms of rib stiffening.

Fittings, Loose Gear and Ropes**Chapter 6**

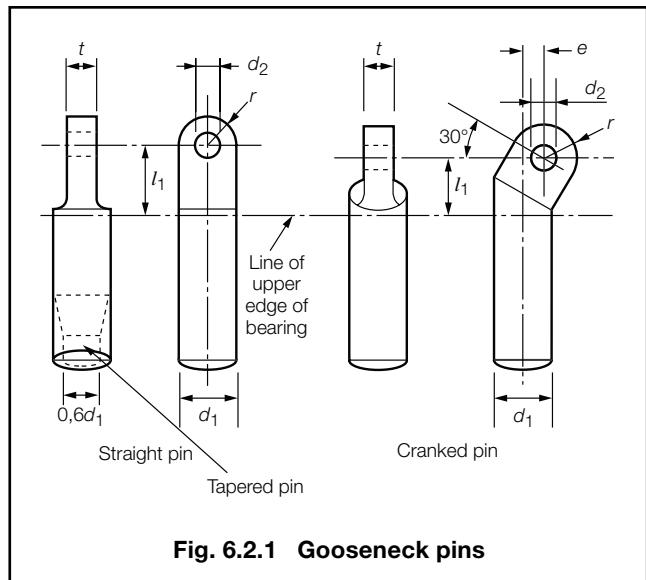
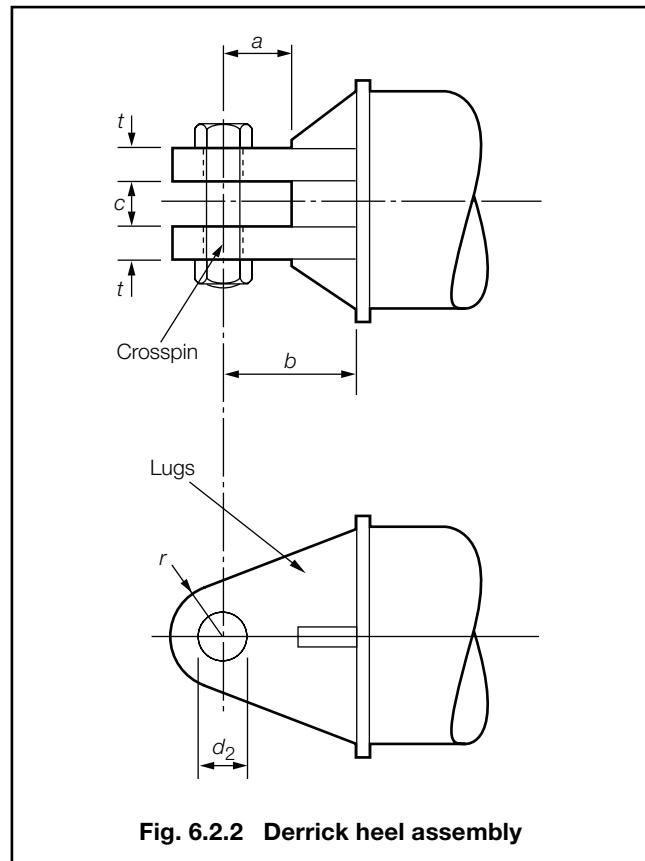
Section 2

Table 6.2.3 Dimensions of gooseneck bearing brackets

Gooseneck pin diameter, d_1	a	b	c	d_3	t_1	t_2
50	95	45	70	85	12	10
55	95	45	80	90	12	10
60	95	50	90	100	12	10
65	120	50	100	110	12	10
70	120	60	115	120	12	10
80	140	60	130	130	12	10
90	140	70	145	140	12	10
100	175	70	160	160	15	10
110	175	80	175	170	20	10
120	215	80	190	190	20	12
130	215	90	205	200	22	12
140	215	90	220	210	25	12
155	235	100	235	230	30	15
160	235	100	240	235	30	15
170	235	100	250	250	30	15
180	235	100	270	260	30	15
190	255	110	285	280	33	18
200	255	110	300	290	35	18
225	255	120	315	325	40	20
250	275	130	330	360	40	20
275	275	140	345	395	40	20

NOTES

1. All dimensions are given in millimetres and are illustrated in Fig. 6.2.3.
2. The width of bracket at the mast (dimension w in Fig. 6.2.3) is to be not less than 0,67 times the diameter of the mast at that point.

**Fig. 6.2.1 Gooseneck pins****Fig. 6.2.2 Derrick heel assembly**

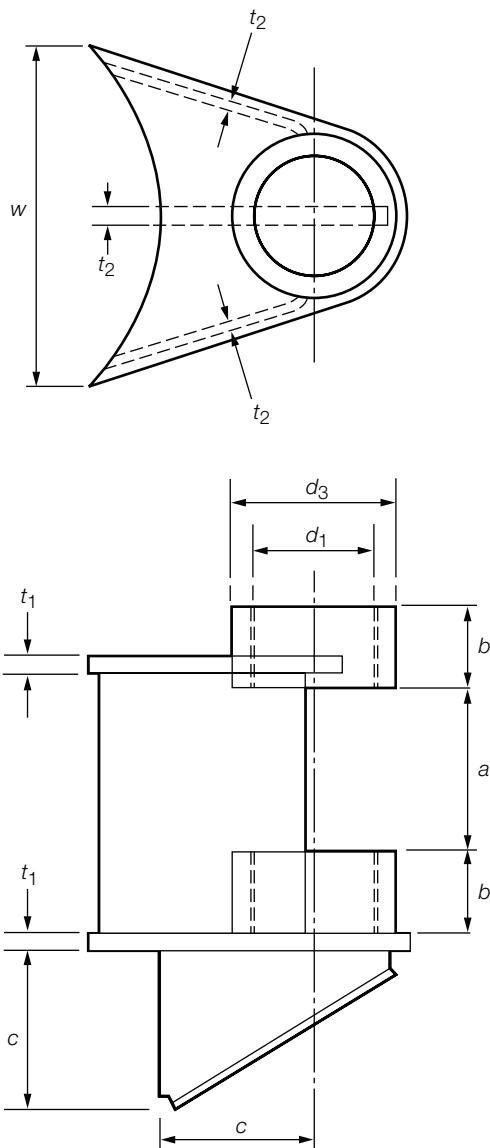


Fig. 6.2.3 Gooseneck bearing

Table 6.2.4 **Stresses in gooseneck and derrick heel assemblies**

Item	Boom axial thrust, T , in tonnes $T \leq 25$ N/mm ²	$25 < T \leq 50$ N/mm ²	$50 < T$ N/mm ²
Gooseneck pin Bending plus direct stress	90	$40 + 2T$	140
Bearing pressure	$20 + 0,5T$	$20 + 0,5T$	45
Derrick heel crosspin Shear stress	$25 + 0,4T$	35	35
Bending plus shear stress	$90 + T$	$90 + T$	140
Bearing pressure	$20 + 0,5T$	$20 + 0,5T$	45
Gooseneck pin collar Horizontal bearing pressure			10 N/mm ²
Minimum diameter			$1,15d_1$ mm
Bearing bracket			Total stress in any part is not to exceed $0,45\sigma_y$

2.2 Swivel bearing assemblies

2.2.1 The safe working load of the assembly is to be taken as the least of the values determined separately for the individual components. Standard dimensions for the trunnion, pin and bearing bracket with corresponding safe working loads are given in Tables 6.2.5 and 6.2.6 and the items are illustrated in Fig. 6.2.4.

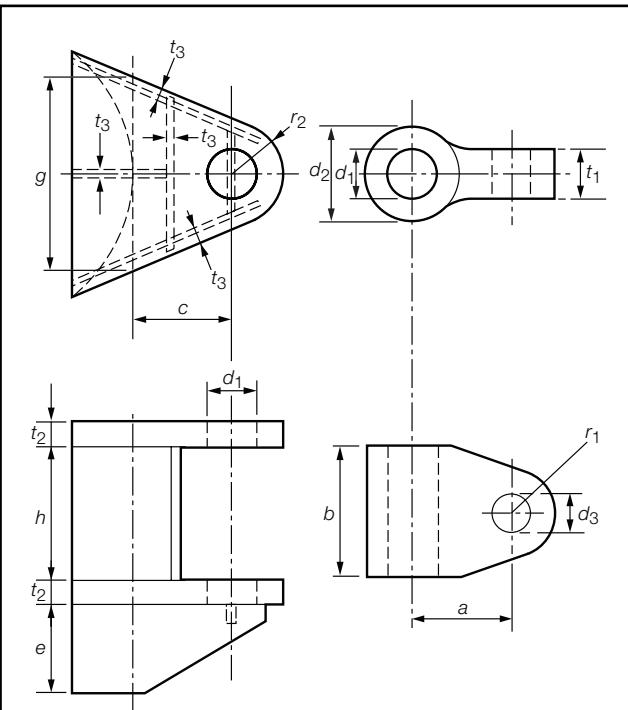


Fig. 6.2.4 Swivel bearing assemblies

2.1.2 Where arrangements other than those covered by the Tables or by recognized standards are proposed, the dimensions of the components of the assembly are to be such that the stresses given in Table 6.2.4 are not exceeded.

2.1.3 Where a gooseneck pin is supported by two bearings, the diameter of the pin in way of the lower bearing may be reduced to $0,6d_1$ provided the bearings are spaced such that $(a + b)$ is greater than $3,0d_1$, see Fig. 6.2.3 for illustration of these terms. Proposals for a greater reduction on large gooseneck pins will be considered.

Fittings, Loose Gear and Ropes**Chapter 6**

Section 2

Table 6.2.5 Dimensions of swivels

SWL, in tonnes	<i>a</i>	<i>b</i>	<i>d</i> ₁	<i>d</i> ₂	<i>d</i> ₃	<i>r</i> ₁	<i>t</i> ₁	<i>d</i> pin
2,0	75	90	34	65	25	25	22	32
4,0	95	110	42	80	33	33	30	40
6,3	110	130	47	90	42	43	40	45
8,0	120	150	52	100	48	48	45	50
10,0	130	170	57	110	52	55	50	55
12,5	140	190	62	120	56	60	55	60
16,0	150	215	68	130	65	65	60	65
20,0	170	240	78	150	74	70	65	75
25,0	180	270	83	160	78	75	70	80
32,0	190	300	93	180	86	85	80	90
40,0	210	330	103	200	96	95	90	100
50,0	235	380	113	220	106	105	100	110
63,0	260	410	123	240	116	115	110	120
80,0	295	480	134	260	131	135	125	130
100,0	330	540	144	280	146	148	140	140

NOTES

1. All dimensions are given in millimetres and are illustrated in Fig. 6.2.4.
2. SWL is the required SWL of the bearing assembly.

Table 6.2.6 Dimensions of swivel bearing brackets

SWL, in tonnes	<i>c</i>	<i>d</i> ₁	<i>e</i>	<i>g</i>	<i>h</i>	<i>t</i> ₂	<i>t</i> ₃	<i>r</i> ₂
2,0	75	34	75	140	95	12	10	35
4,0	95	42	80	160	115	15	10	43
6,3	115	47	90	180	135	20	10	48
8,0	140	52	110	200	155	25	10	55
10,0	160	57	125	230	175	25	12	60
12,5	175	62	140	260	195	30	12	65
16,0	190	68	150	290	223	30	12	70
20,0	205	78	160	320	248	35	15	80
25,0	220	83	180	340	278	35	15	85
32,0	220	93	190	370	308	40	15	95
40,0	245	103	190	410	338	45	15	105
50,0	270	113	210	450	388	45	18	115
63,0	300	123	230	500	420	50	20	125
80,0	335	134	260	560	490	50	20	135
100,0	375	144	300	630	550	55	20	148

NOTES

1. All dimensions are given in millimetres and are illustrated in Fig. 6.2.4.
2. SWL is the required SWL of the bearing assembly.

2.2.2 Where arrangements other than those covered by the Tables or by recognized standards are proposed, the dimensions of the components of the assembly are to be such that the stresses given in Table 6.2.7 are not exceeded.

Table 6.2.7 Stresses in swivel bearing assemblies

Item	Safe working load, in tonnes SWL ≤ 25	Safe working load, in tonnes 25 < SWL
Swivel pin	N/mm ²	N/mm ²
Shear stress	25 + 0,4 SWL	35
Bearing pressure	40 + 0,6 SWL	55
Trunnion eyeplate		50
Shear pullout at hole		
Bearing bracket	Total stress on any part is not to exceed 0,45σ _y	

NOTES

Safe working load is the required SWL of the bearing assembly.

Fittings, Loose Gear and Ropes**Chapter 6**

Section 2

2.3 Fixed eyeplates

2.3.1 Fixed eyeplates at the derrick boom head are generally to be in accordance with the dimensions given in Table 6.2.8.

2.3.2 The dimensional details of the fittings may differ at opposite ends depending on the loads to be carried. Where the fitting is made continuous and of the larger thickness required by the Table, care is to be taken to ensure that this thickness is suitable for the proposed shackle or other attachment to the eyeplate.

2.3.3 It should be noted that an increase in the dimension e_1 or e_2 will result in an increased bending moment on the derrick boom and this may result in increased scantlings.

2.3.4 Fixed eyeplates attached to the ship's structure for use with the cargo gear are to have dimensions generally in accordance with Table 6.2.9. Attention is to be given to the stresses which may arise from applied forces not in the plane of the eyeplate. Where the dimensions of the eyeplate differ from the Table values, the safe working load may be taken as:

$$\text{SWL} = \frac{0,04d^2 t^2}{4d(b + 0,5d) + t(a + 0,4d)} \text{ tonnes}$$

where dimensions a , b , d and t are illustrated in Fig. 6.2.6. Where the cross-section of the eyeplate varies, the minimum value of $(d \times t)$ is to be used for the calculation.

2.3.5 Adequate support is to be provided by the ship structure in way of the eyeplate. Arrangements to give effective spread of load into the surrounding structure may be required, see also Ch 2,8.9.

Table 6.2.9 Dimensions of eyeplates at ship's structure

SWL, in tonnes	a	b	d	t
1,0	35	22	16	16
1,6	42	24	20	20
2,0	50	27	25	25
2,5	55	29	25	25
3,2	66	33	30	30
4,0	77	36	35	35
5,0	87	41	40	40
6,3	91	45	40	40
8,0	101	51	50	50
10,0	117	56	50	50
12,5	128	61	60	60
16,0	145	67	60	60
20,0	157	73	70	70
25,0	170	80	80	80
32,0	194	88	90	90
40,0	220	98	100	100
50,0	240	108	110	110

NOTE
All dimensions are given in millimetres and are illustrated in Fig. 6.2.6.

2.4 Built-in sheaves

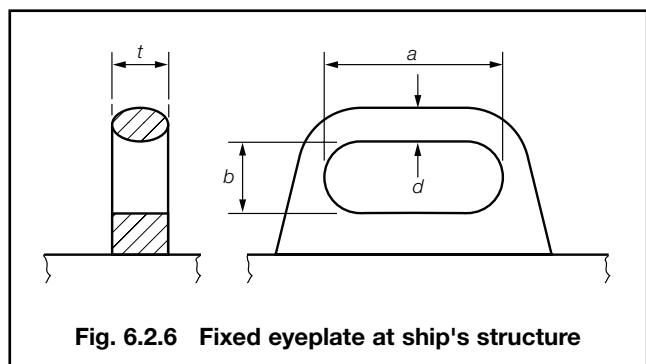
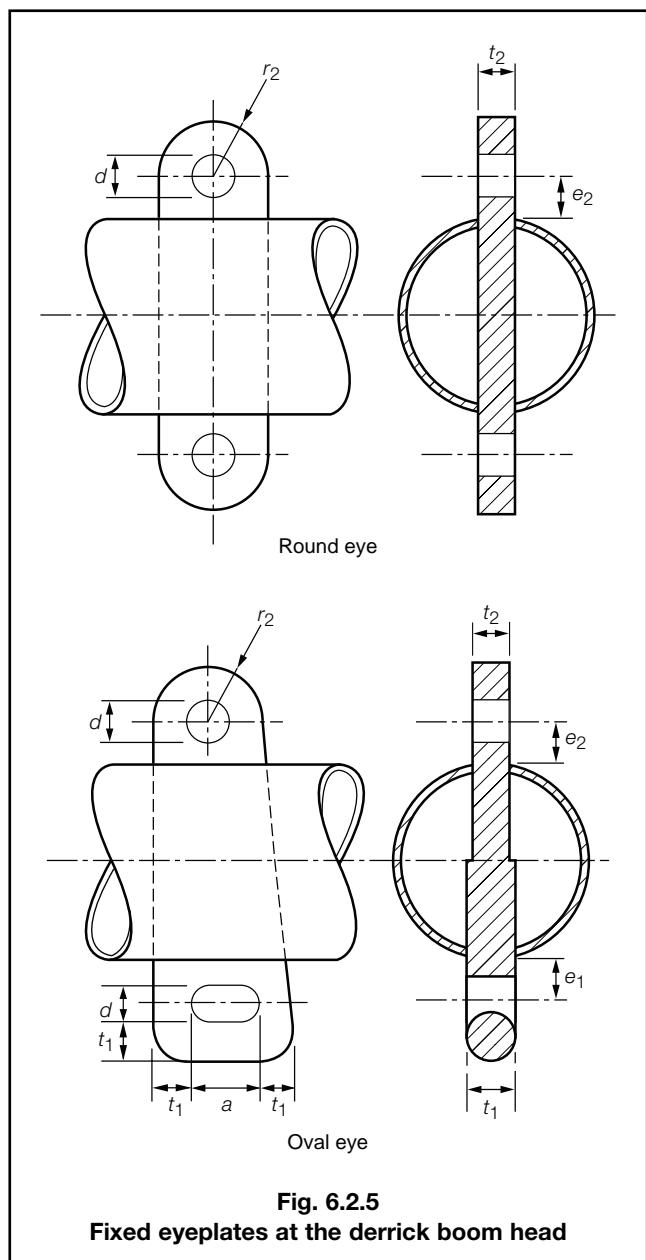
2.4.1 Where a built-in sheave is fitted in the derrick boom, the diameter of the sheave is to be not less than that required for the rope nor less than 1,2 times the derrick boom diameter at that point. The material, construction and design of the sheave, sheave pin and supports are to be in accordance with Section 3.

Table 6.2.8 Dimensions of fixed eyeplates at the derrick boom head

SWL, in tonnes	Oval eye a	Round eye b	e_1	t_1	d	r_2	e_2	t_2
2,0	50	27	50	25	25	25	40	22
2,5	55	29	54	25	27	28	40	25
3,2	66	33	57	30	30	30	45	28
4,0	77	36	65	35	33	33	50	30
5,0	87	41	70	40	39	38	55	35
6,3	91	45	75	40	42	43	60	40
8,0	101	51	80	50	48	48	70	45
10,0	117	56	90	50	52	55	75	50
12,5	128	61	100	60	56	60	80	55
16,0	145	67	115	60	65	65	85	60
20,0	157	73	125	70	74	70	95	65
25,0	170	80	135	80	78	75	100	70
32,0	194	88	150	90	86	85	110	80
40,0	220	98	170	100	96	95	120	90

NOTES

1. All dimensions are given in millimetres and are illustrated in Fig. 6.2.5.
2. The dimensions e_1 and e_2 are to be measured from the outside surface of the derrick boom tube, or the outside surface of the doubling plate, if fitted.



■ Section 3

Blocks

3.1 General

3.1.1 A typical cargo block is shown diagrammatically in Fig. 6.3.1 with the component items labelled for reference.

3.1.2 The ultimate strength of the block as an assembled unit is in no case to be less than five times the resultant load for which the block is designed.

3.1.3 The safe working load of each block is to be appropriate to its particular position in the rig and is to be not less than the resultant load determined in accordance with the appropriate Chapter of this Code. Blocks are not to be used in positions other than those for which they were approved without first confirming that their safe working load is at least that required for the proposed location.

3.1.4 The required safe working load of the block is to be determined by reference to the resultant load, R , imposed on the block at its particular position in the rig.

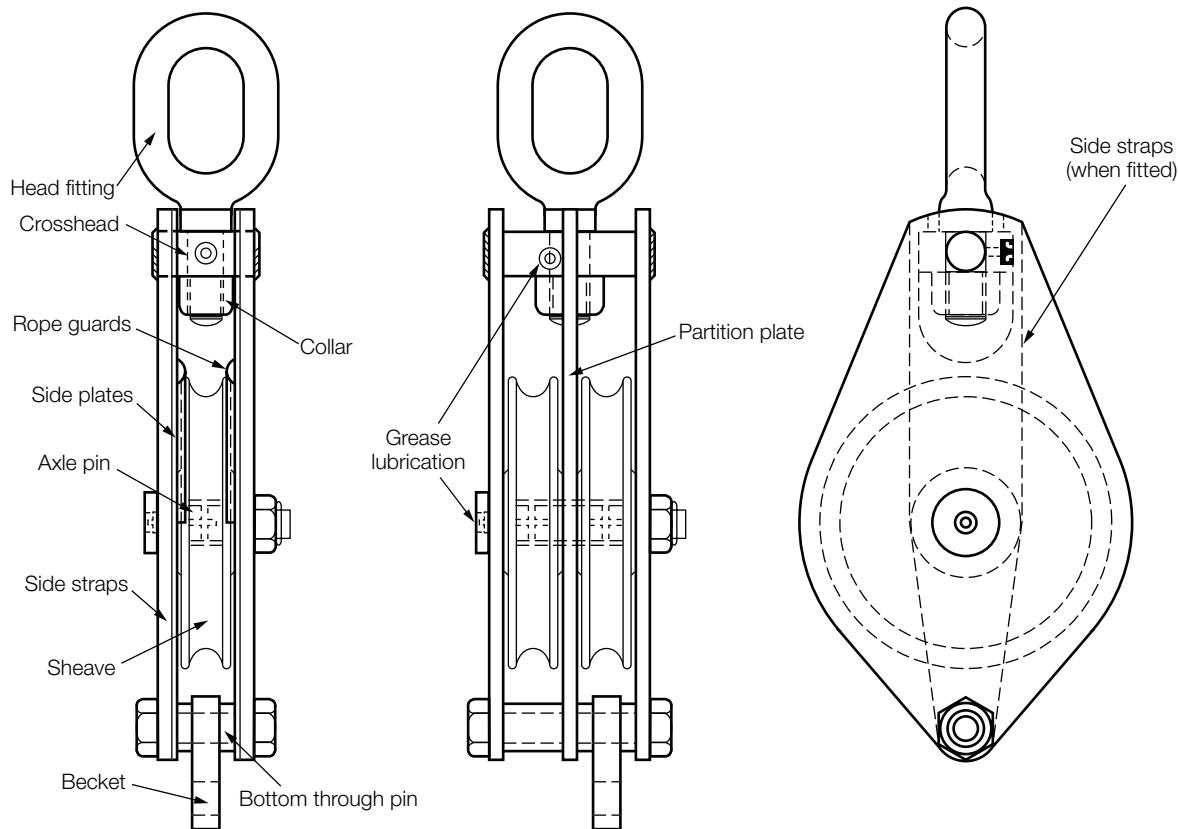
3.1.5 The safe working load of a single sheave block is assessed on one particular condition of loading, namely where the block is suspended by its head fitting and the cargo load attached to a wire passing round the sheave such that the hauling part is parallel to the part to which the load is attached, see Fig. 6.3.2. The SWL marked on the block is the weight, W tonnes that can safely be lifted by the block, when rigged in this way. The resultant load, R , on the head fitting (neglecting friction) is, however, twice the SWL marked on the block, i.e., $2W$ tonnes. The block and head fitting must, therefore, be designed to take a resultant force of $2W$ tonnes and the proof load applied to the head fitting must be based on this resultant force. That is, the proof load will be $4W$ tonnes.

3.1.6 When the same block is rigged as a lower cargo block (the load being attached to the head fitting), the SWL marked on the block is unchanged, but the resultant force on the head fitting is only W tonnes. As the block has been designed to withstand a resultant load on the head fitting of $2W$ tonnes it follows that the block is safe to support a cargo load of $2W$ tonnes.

3.1.7 For single sheave blocks with beackets, the SWL marked on the block is to be not less than one-half the resultant load on the head fitting.

3.1.8 Fig. 6.3.2 gives examples of the use of single sheave blocks and the method of obtaining their SWLs. It should be noted that in all cases with single sheave blocks, the shackle or link securing the block is to be marked with an SWL equal to twice the SWL marked on the block.

3.1.9 The safe working load marked on any multiple sheave block is to correspond to the maximum resultant load on the head fitting of that block.

**Fig. 6.3.1 Typical cargo block**

3.2 Design loads and stresses

3.2.1 The percentage of the resultant load on the head fitting which is transmitted by a sheave is to be taken as not less than the value given in Table 6.3.1.

3.2.2 The percentage of the resultant load on the head fitting which is transmitted to the side straps and partition plates of the sheave is to be taken as not less than the value given in Table 6.3.2.

3.2.3 The load on a becket, where fitted, is to be taken as the maximum load to which it may be subjected in service.

3.2.4 The stresses in the component parts of the block are to be determined from the loads transmitted from the sheaves and straps and are not to exceed the values given in Table 6.3.3.

(c) Any block in the rig of a lifting appliance having SWL greater than 20 t.

3.3.2 Cast nylon sheaves may also be used for general cargo handling applications when the manufacturer can indicate satisfactory service experience. Attention is drawn, however, to the fact that whilst tests have indicated longer service life for ropes used with cast nylon sheaves, the ropes do not exhibit the normal warning signs of broken wires but may break without external warning by internal rope fatigue. In consequence it is recommended that one steel sheave is included in the reeving arrangement.

3.3.3 The diameter of the sheave is to be measured to the base of the rope groove and is to be not less than as given in Table 6.3.4.

3.3.4 The depth of the groove in the sheave is to be not less than three quarters of the rope diameter. A depth equal to the rope diameter is recommended. The contour at the bottom of the groove is to be circular over an angle of 128° and its radius is to be not less than as given in Table 6.3.5.

3.3 Materials and construction

3.3.1 Sheaves may be forged or fabricated from steel plate. In general, castings in steel or spheroidal graphite iron may be accepted but grey cast iron or malleable cast iron is not to be used for sheaves in the following circumstances unless specially agreed:

- (a) Single sheave block having SWL greater than 10 t.
- (b) Multiple sheave block having SWL greater than 20 t.

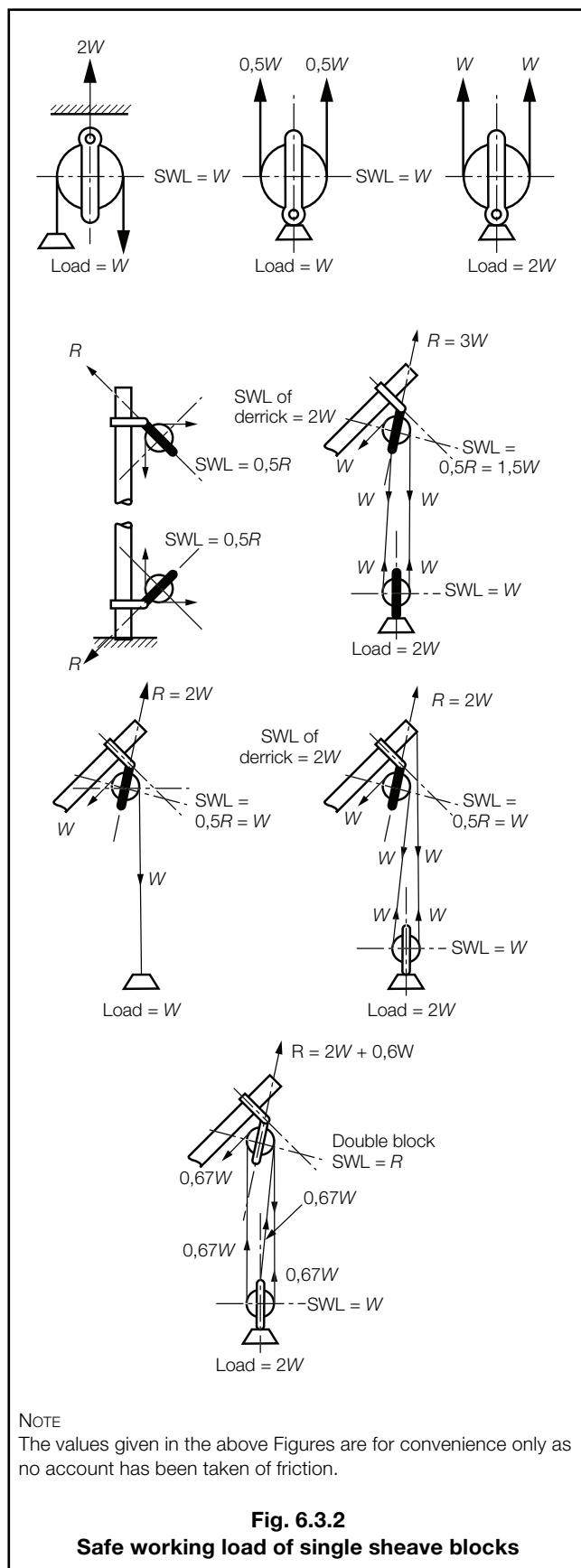


Fig. 6.3.2
Safe working load of single sheave blocks

3.3.5 Side and partition plates and straps are to be castings or fabricated from steel plate. Malleable cast iron may be used when permitted for sheaves, see 3.3.1. The plates are to project beyond the sheaves to provide ample protection for the rope. Means are to be provided to prevent the rope from jamming between the sheave and the side or partition plates by minimizing the clearance or by fitting suitable guards.

3.3.6 Snatch blocks are to be well designed and arrangements are to be provided to ensure that the block remains closed at all times when it is in use.

3.3.7 Crossheads and beackets may be cast, forged or machined from plate.

3.3.8 Axle pins are to be positively secured against rotation and lateral movement. The surface finish of the pin is to be suitable for the type of bearing to be used.

3.3.9 Provision is to be made for lubricating all bearings and swivel head fittings without dismantling the block and for withdrawing the axle pin for inspection.

3.4 Blocks for fibre ropes

3.4.1 Blocks intended for use with fibre ropes are not to be fitted with more than three sheaves and a becket or with four sheaves and no becket.

3.4.2 The diameter of the sheave measured to the base of the rope groove is to be not less than five times the nominal diameter of the rope. The depth of the groove is to be not less than one third the diameter of the rope. The contour at the bottom of the groove is to be of a radius in accordance with Table 6.3.5.

3.4.3 Proposals to use materials other than steel or iron castings for the sheaves and body of the block will be considered. Bearing pressures and stresses are to be appropriate to the materials used.

Fittings, Loose Gear and Ropes**Chapter 6**

Section 3

Table 6.3.1 Percentage load transmitted by a sheave

Type of block	Number of sheaves	Bushed or plain bearings		Roller or ball bearings	
		Without becket	With becket	Without becket	With becket
Double	2	52	43	51	42
Treble	3	37	32	35	30
Fourfold	4	29	26	27	24
Fivefold	5	24	22	22	20
Sixfold	6	21	20	19	18
Sevenfold	7	19	18	17	16
Eightfold	8	17	16	15	14

NOTES
Friction allowance taken as 5 per cent for bushed or plain bearings and 2 per cent for roller or ball bearings.

Table 6.3.2 Percentage load on side plates or supporting straps

Type of block	Number of sheaves	Number of supports		Bushed or plain bearings		Roller or ball bearings	
		Inner	Outer	Partition	Side strap	Partition	Side strap
Double	2	1	2	63	20	63	19
Treble	3	2	2	40	15	38	14
Fourfold	4	3	2	32	12	30	11
Fivefold	5	4	2	26	10	24	9
Sixfold	6	5	2	23	9	21	8
Sevenfold	7	6	2	21	8	18	7
Eightfold	8	7	2	19	7	16	6

NOTES
1. Friction allowance taken as 5 per cent for bushed or plain bearings and 2 per cent for roller or ball bearings.
2. Where a becket is fitted, the partitions and straps are to be designed to take account of the loads imposed on the block.

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Sections 3 & 4

Table 6.3.3 Allowable stresses in blocks

Item	Allowable stress
Sheave bush to axle pin	Bearing pressure: Single sheave 39 N/mm ² Multiple sheaves 31 N/mm ²
Axle pin to supporting straps and partitions	Bearing pressure: 154 N/mm ²
Axle pin and through bolts	Shear stress: Mild steel 62 N/mm ² High tensile steel 77 N/mm ² Bending stress: 0,35σ _y N/mm ²
Becket to through bolt	Bearing pressure: 39 N/mm ²
Straps and beackets, see Fig. 6.3.3	Shear pullout at end: 54 N/mm ² on area 2 x (a x t) Tensile stress at side: Mild steel 77 N/mm ² High tensile steel 85 N/mm ² on area 2 x (b x t)
Tensile stress in shanks of head fittings (based on core area)	Mild steel: $R \leq 50 \quad \sigma_t = 62 \text{ N/mm}^2$ $50 < R \leq 75 \quad \sigma_t = (9,6R + 32) \text{ N/mm}^2$ $75 < R \quad \sigma_t = 77 \text{ N/mm}^2$ High tensile steel: 85 N/mm ²
Collars and nuts of shanks	Bearing stress: 10 N/mm ² Minimum diameter: (1,5d + 3) mm

NOTES

1. High tensile steel is defined as steel having a tensile strength not less than 540 N/mm².
2. R = resultant load on the head fitting, in tonnes,
d = diameter of shank of head fitting, in mm.

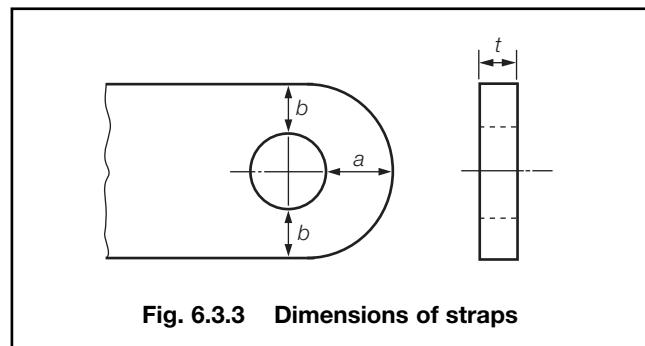
Table 6.3.4 Diameter of sheaves for wire rope

Rope use	Sheave diameter, in mm	
	Running ropes	Fixed span ropes
Derrick systems	14d	10d
Vehicle ramps		
Cranes		
Derrick cranes		
Vehicle lifts		
Cargo lifts		
Mechanical lift docks	19d	10d
Diving systems (excluding umbilicals)		
Other lifting appliances		
Passenger lifts	40d	10d

NOTE
Where d is the diameter of the rope.

Table 6.3.5 Radius of sheave groove

Nominal diameter of rope, in mm	Radius in groove, in mm
16	8,5
18	9,5
20	11,0
22	12,0
24	13,0
26	14,0
28	15,0
32	17,0
36	19,5
40	21,5
44	23,5
48	26,0
52	28,0
56	30,5
60	32,5

**Fig. 6.3.3 Dimensions of straps****Section 4****Spreaders and lifting beams****4.1 General**

4.1.1 The safe working load of a spreader or lifting beam is to be the maximum load which the item is certified to lift. It should be noted that the SWL of the lifting appliance with which the spreader or lifting beam is to be used is to be adequate for the SWL of the beam plus its self-weight.

4.1.2 Steel used in the construction of the beam is to be of weldable quality in accordance with 1.2.

4.1.3 Special attention is to be paid to structural continuity and abrupt changes of section are to be avoided. Adequate reinforcement is to be fitted in way of concentrated loads at lifting points. Welding and weld details are to be to the satisfaction of LR.

Fittings, Loose Gear and Ropes

Chapter 6

Sections 4 & 5

4.2 Loading and allowable stress

4.2.1 The beam is to be designed such that the maximum stresses do not exceed the following values when the beam is subjected to its SWL:

	SWL \leq 10 t	SWL \geq 160 t
Bending stress	$0,45\sigma_y$	$0,67\sigma_y$
Shear stress	$0,30\sigma_y$	$0,40\sigma_y$
Combined stress	$0,50\sigma_y$	$0,90\sigma_y$
Bearing stress	$0,50\sigma_y$	$0,90\sigma_y$

Intermediate values are to be determined by interpolation.

4.2.2 The beam is to be designed to ensure adequate lateral stability under load.

4.2.3 Where the beam is designed as a frame lifted by an arrangement of slings, the structure is to be designed to resist the compressive forces which are generated. In this respect, the factor of safety of each component against compressive buckling under the appropriate test load is to be not less than 1,3. See Chapter 9 for test loads.

■ Section 5 Loose gear

5.1 Shackles

5.1.1 The safe working load of any shackle securing a block is to be not less than the SWL marked on the block, except in the case of single sheave blocks where the SWL is to be not less than twice that marked on the block.

Table 6.5.1 Dimensions of Dee shackles

Safe working load, in tonnes	a	b	Mild steel		Higher tensile steel	
			d_1	d_2	d_1	d_2
1,0	20	44	13	15	11	12
1,6	25	55	17	19	13	15
2,0	28	62	19	21	15	17
2,5	31	69	21	24	17	19
3,2	35	78	24	27	19	21
4,0	40	87	26	30	21	23
5,0	44	97	29	33	23	26
6,3	50	109	33	37	26	29
8,0	56	123	37	42	29	33
10,0	63	138	41	47	33	37
12,5	70	154	46	53	36	42
16,0	79	174	52	60	41	47
20,0	89	195	59	67	46	52
25,0	99	218	65	75	51	59
32,0	112	247	74	84	58	66
40,0	125	275	83	94	65	74
50,0	140	308	92	106	72	83
63,0	157	346	104	119	81	93
80,0	177	390	117	134	91	105

NOTES

1. All dimensions are given in millimetres and are illustrated in Fig. 6.5.1.
2. High tensile steel is defined as steel having a tensile strength not less than 540 N/mm².
3. Diameter d_3 is to be not less than $2d_2$.

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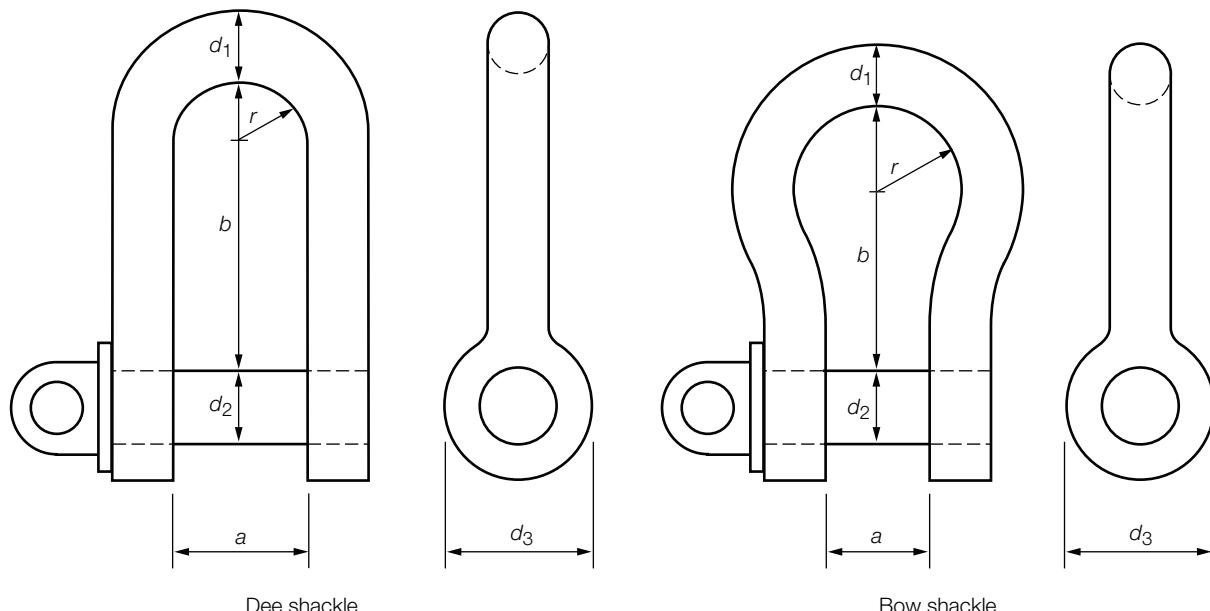
Section 5

Table 6.5.2 Dimensions of Bow shackles

Safe working load, in tonnes	<i>a</i>	<i>b</i>	$2r$	Mild steel		Higher tensile steel	
				<i>d</i> ₁	<i>d</i> ₂	<i>d</i> ₁	<i>d</i> ₂
1,0	20	50	34	14	16	12	13
1,6	25	63	43	18	20	15	16
2,0	28	70	48	20	22	17	18
2,5	31	78	53	23	25	18	20
3,2	35	89	60	25	28	21	22
4,0	40	99	67	28	31	23	25
5,0	44	111	75	32	35	26	28
6,3	50	124	84	36	39	29	32
8,0	56	140	95	40	44	33	36
10,0	63	157	106	45	49	36	40
12,5	70	175	119	50	55	41	44
16,0	79	198	135	56	62	46	50
20,0	89	221	150	63	69	51	56
25,0	99	248	168	70	77	57	63
32,0	112	280	190	80	87	65	71
40,0	125	313	213	89	98	72	79
50,0	140	350	248	99	109	81	89
63,0	157	394	267	112	123	91	100
80,0	177	444	301	126	138	102	112

NOTES

1. All dimensions are given in millimetres and are illustrated in Fig. 6.5.1.
2. High tensile steel is defined as steel having a tensile strength not less than 540 N/mm².
3. Diameter d_3 is to be not less than $2d_2$.

**Fig. 6.5.1 Shackles**

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Section 5

Table 6.5.3 Values of c for shackles

Minimum tensile strength of steel, in N/mm ²	c		
	Side	Crown	Pin
330	0,0076	0,0082	0,0072
430	0,0105	0,0113	0,0099
540	0,0140	0,0151	0,0132

5.2 Hooks

5.2.1 The safe working load of a hook is the maximum load that the hook is certified to lift in service.

5.2.2 Hooks may be of the 'C' or Liverpool type or of the double armed Ramshorn type, as indicated in Fig. 6.5.2. In general, 'C' type hooks are not to be used for safe working loads exceeding 25 t.

5.2.3 Hooks may be of killed mild steel or higher tensile steel. After forging, mild steel hooks are to be normalized and higher tensile steel hooks subjected to a suitable heat treatment.

5.2.4 'C' type hooks are to be so designed as to reduce as far as possible the risk of the hook catching on an obstruction when hoisting and also the risk of the displacement of the load.

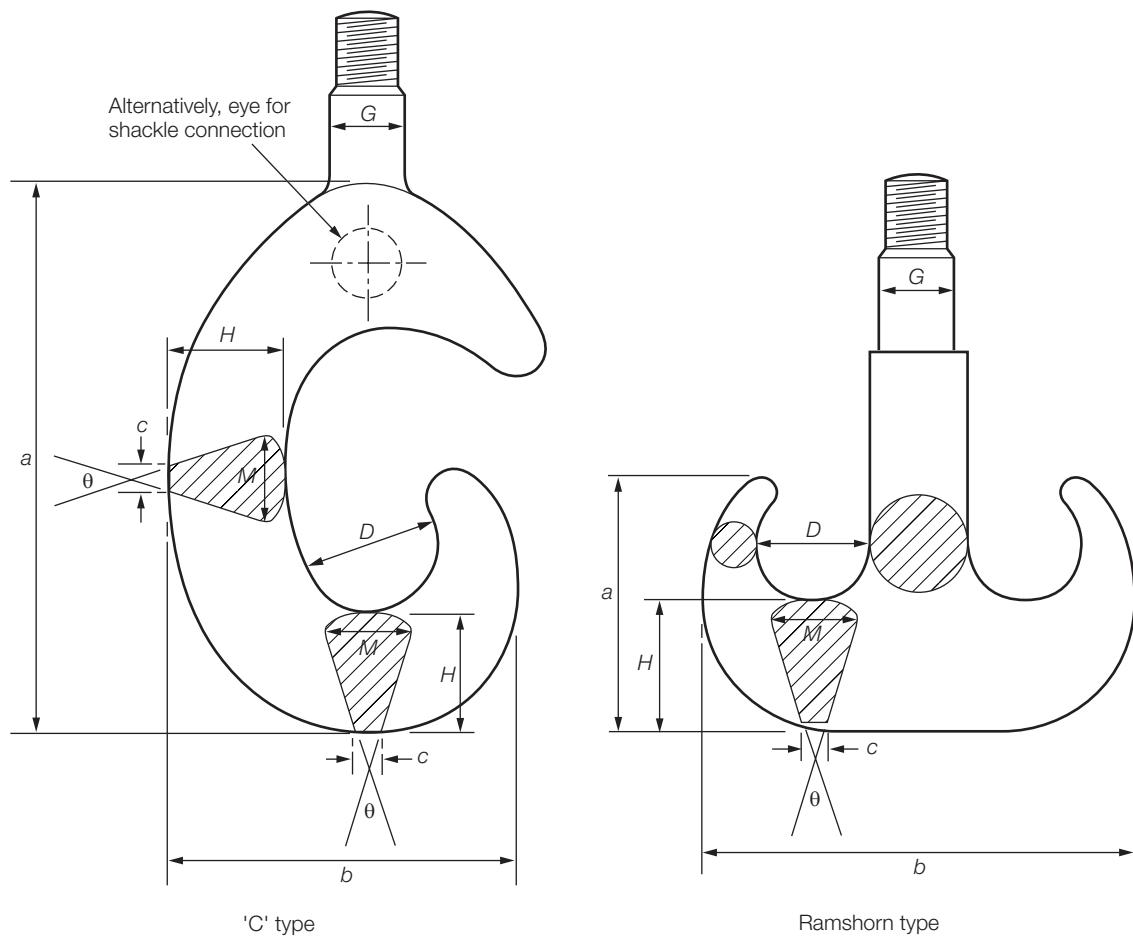
5.2.5 Standard dimensions of 'C' type and Ramshorn hooks are given in Tables 6.5.4 and 6.5.5 respectively for the arrangements as illustrated in Fig. 6.5.2.

5.2.6 Where the hook is not manufactured in accordance with a recognized standard, the safe working load may be taken as:

$$SWL = ck (H - 0,1D)^2 \text{ tonnes}$$

where the dimensions are measured in millimetres and are illustrated in Fig. 6.5.2. The values of c and k are to be obtained from Tables 6.5.6 and 6.5.7.

5.2.7 The shank is to be such that the direct tensile stress complies with Table 6.3.3. Detail design at the end of the threaded section is to be such as to minimize stress concentrations.

**Fig. 6.5.2 Hooks**

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Table 6.5.4 Dimensions of higher tensile steel 'C' hooks

Safe working load, in tonnes	<i>a</i>	<i>b</i>	<i>c</i>	<i>D</i>	<i>H</i>	<i>M</i>	<i>G</i>
1,0	124	78	6	31	26	17	17
1,6	156	98	8	39	33	21	20
2,0	176	110	8	44	37	24	25
2,5	196	123	10	49	41	27	25
3,2	219	138	12	55	46	30	30
4,0	247	156	12	62	52	34	30
5,0	279	176	14	70	59	38	35
6,3	311	196	16	78	66	43	40
8,0	351	221	18	88	74	48	45
10,0	391	246	20	98	82	54	50
12,5	439	276	22	110	92	60	55
16,0	495	311	24	124	104	68	60
20,0	555	349	28	139	117	76	70
25,0	622	392	32	156	131	86	80

NOTES

1. All dimensions are given in millimetres and are illustrated in Fig. 6.5.2.
2. Minimum material tensile strength σ_u 540 N/mm².

Table 6.5.5 Dimensions of higher tensile steel Ramshorn hooks

Safe working load, in tonnes	<i>a</i>	<i>b</i>	<i>c</i>	<i>D</i>	<i>H</i>	<i>M</i>	<i>G</i>
20	238	457	30	121	113	76	89
25	267	511	33	133	126	86	102
32	299	567	37	146	143	97	114
40	329	616	41	162	155	108	127
50	365	683	46	178	174	117	140
63	408	745	51	194	195	132	144
80	452	813	57	213	216	146	152
100	498	883	64	229	241	162	165

NOTES

1. All dimensions are given in millimetres and are illustrated in Fig. 6.5.2.
2. Minimum material tensile strength σ_u 540 N/mm².

Table 6.5.6 Values of *c* for hooks

Minimum tensile strength of steel, in N/mm ²	<i>c</i>	
	'C' hooks	Ramshorn hooks
430	0,0011	0,0016
540	0,0015	0,0021

NOTE
Intermediate values by interpolation.

5.2.8 It should be noted that the safe working load for Ramshorn hooks, derived in accordance with this Section, is appropriate for sling legs at an included angle not exceeding 90°. No increase in SWL is permitted for lesser included angles.

5.2.9 The dimensions and requirements for cast steel hooks will be considered.

5.2.10 Hooks for special purposes, such as for lifting freight containers, are to comply with appropriate recognized national or international standards.

5.3 Swivels and lifting eyes

5.3.1 The safe working load of the swivel or lifting eye is to be equal to the maximum load for which the item is certified.

5.3.2 Lifting eyes and lug fittings as detailed in this Section may be used in association with swivel bow pieces or with another item of loose gear such as a cargo block.

5.3.3 Swivels are to be fitted with plain bearings or with ball or roller thrust bearings.

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Table 6.5.7 Values of k for hooks

$\frac{M}{H}$	θ							
	40°	30°	25°	20°	15°	10°	5°	0°
0,55	0,48	0,75	0,85	0,92	0,98	1,03	1,06	1,10
0,65	0,82	1,01	1,08	1,12	1,16	1,20	1,23	1,27
0,75	1,07	1,18	1,22	1,27	1,30	1,34	1,37	1,40
0,85	1,16	1,30	1,33	1,36	1,40			

5.3.4 Triangular lifting eyes are to be designed for an included angle between the sling legs not exceeding 90° and they are not to be used for single point loading. Ball or roller thrust bearings are to be incorporated in the swivel arrangements.

5.3.5 Standard dimensions for mild steel, swivel bow pieces, round, oval and triangular eyes and lug fittings are given in Tables 6.5.8 to 6.5.11 for the arrangements illustrated in Figs. 6.5.3 to 6.5.6.

5.3.6 Items whose dimensions differ from those given in the Tables may be designed in accordance with the requirements given in Tables 6.5.12 and 6.5.14.

5.4 Chains, links and rings

5.4.1 The overall dimensions of the links of chain are to be within the following limits:

	Length	Breadth
Short link	4,5d – 5,0d	3,25d – 3,5d
Long link	7,0d – 9,0d	3,25d – 3,5d

where

d is the nominal diameter of the chain.

Table 6.5.8 Dimensions of bow pieces for swivels

Safe working load, in tonnes	a	b	d_1	d_2	e
1,0	37	64	13	20	20
1,6	46	80	16	25	25
2,0	53	92	18	25	29
2,5	60	104	21	30	32
3,2	67	116	23	30	36
4,0	74	128	26	35	40
5,0	83	144	29	40	45
6,3	92	160	32	40	50
8,0	104	180	36	45	56
10,0	117	204	41	55	64
12,5	131	228	46	60	71

NOTE

All dimensions are given in millimetres and are illustrated in Fig. 6.5.3.

Table 6.5.9 Dimensions of round and oval eyes

Safe working load, in tonnes	Shank	Round			Oval			
		d_1	d_2	d_3	b	g	d_4	e
1,0	M18	11	24	48	21	12	14	
1,6	M22	14	30	58	26	16	18	
2,0	M24	16	34	58	26	16	18	
2,5	M27	18	39	72	32	21	23	
3,2	M30	20	44	72	32	21	23	
4,0	M33	22	48	94	40	26	28	
5,0	M36	25	54	94	40	26	28	
6,3	M42	27	60	108	45	29	32	
8,0	M45	31	68	115	49	32	35	
10,0	M52	35	76	125	54	36	39	
12,5	M56	39	86	144	60	41	44	
16,0	M64			163	66	46	49	
20,0	M72 x 6			173	72	56	54	
25,0	M76 x 6			192	80	56	59	
32,0	M80 x 6			216	90	60	64	
40,0	M90 x 6			240	100	66	70	
50,0	M100 x 6			264	110	74	78	
63,0	M110 x 6			290	120	84	89	
80,0	M120 x 6			325	135	94	99	
100,0	M130 x 6			360	150	105	111	

NOTES

All dimensions are given in millimetres and are illustrated in Fig. 6.5.4.

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Table 6.5.10 Dimensions of triangular lifting eyes

Safe working load, in tonnes	Shank <i>d</i> ₁			Top		Side		Bottom	
		<i>a</i>	<i>b</i>	<i>e</i>	<i>f</i>	<i>g</i>	<i>h</i>	<i>j</i>	<i>k</i>
20	M72 x 6	475	400	48	95	66	95	94	95
25	M76 x 6	515	445	51	108	72	108	100	108
32	M80 x 6	565	500	55	120	79	120	108	120
40	M90 x 6	630	550	59	133	86	133	117	133
50	M100 x 6	675	600	64	146	94	146	127	146
63	M110 x 6	740	660	71	150	104	150	139	150
80	M120 x 6	815	725	78	158	115	158	153	158
100	M130 x 6	880	795	86	178	127	178	168	178

NOTES

All dimensions are given in millimetres and are illustrated in Fig. 6.5.5.

Table 6.5.11 Dimensions of lug fittings

Safe working load, in tonnes	Shank <i>d</i> ₁			<i>b</i>	<i>d</i> ₂	<i>d</i> ₃
		<i>a</i>				
1,0	M18	19		8	17	35
1,6	M22	23		11	21	45
2,0	M24	26		12	23	50
2,5	M27	29		13	25	55
3,2	M30	32		14	28	60
4,0	M33	35		15	31	65
5,0	M36	39		18	37	75
6,3	M42	45		20	40	85
8,0	M45	49		23	46	95
10,0	M52	58		26	50	110
12,5	M56	64		28	54	120
16,0	M64	70		30	62	130
20,0	M72 x 6	74		33	70	140
25,0	M76 x 6	80		35	74	150
32,0	M80 x 6	90		40	82	170

NOTES

All dimensions are given in millimetres and are illustrated in Fig. 6.5.6.

5.4.2 The certified safe working load of short or long link chain is not to exceed the values derived from Table 6.5.15. Proposals for the use of alloy steel chains will be specially considered.

5.4.3 The safe working load for links or rings is not to be greater than the value obtained from Table 6.5.16.

5.5 Miscellaneous items

5.5.1 The triangle plate for use with a span chain or with union purchase cargo runners is to be provided with three holes, of diameter not less than 1,25 times the diameter of the associated shackle pin. One of the holes may be extended as a slot to facilitate reeving of the shackle.

5.5.2 The corners of the plate are to be radiused. The corner radius, measured from the centre of each hole is not to be less than the diameter of the hole. The thickness of the plate is to be not less than one-half the width of jaw of the associated shackle. The radius of the corners and thickness of the plate are to be such that, when subjected to the safe working load, the mean tensile stress in the material around the hole does not exceed $(25 + \text{SWL}) \text{ N/mm}^2$, where the SWL is measured in tonnes.

5.5.3 Where a union purchase swivel assembly is formed of a ring to which the hook and runners are connected by swivels, the ring is to comply with 5.4.3.

5.5.4 Tubular bodies and end fittings of rigging screws are to be of steel having a tensile strength not less than 350 N/mm^2 . The tensile stress in the body and in the shanks of the end fittings is not to exceed $(25 + \text{SWL}) \text{ N/mm}^2$ where SWL is the safe working load, in tonnes, of the rigging screw.

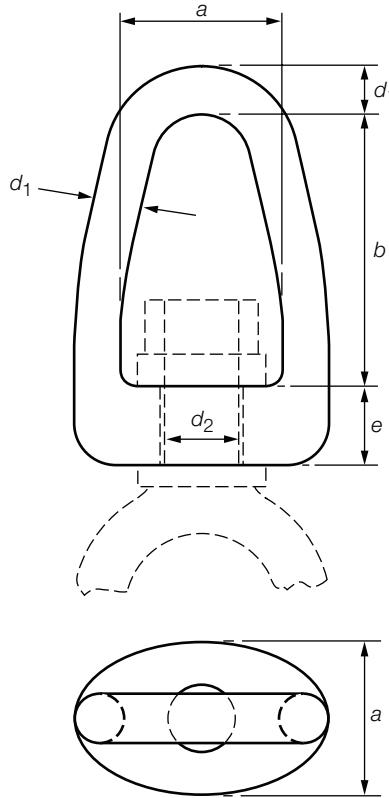


Fig. 6.5.3 Bow piece for swivel

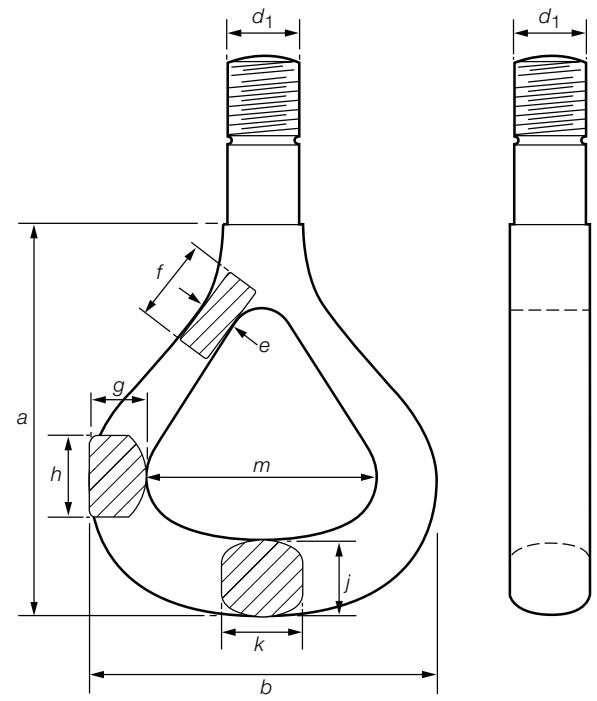


Fig. 6.5.5 Triangular lifting eye

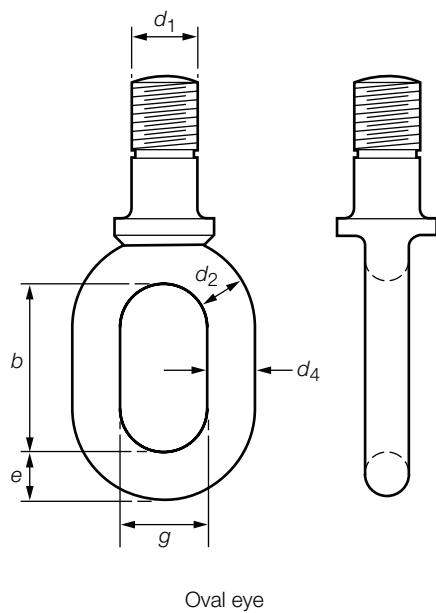
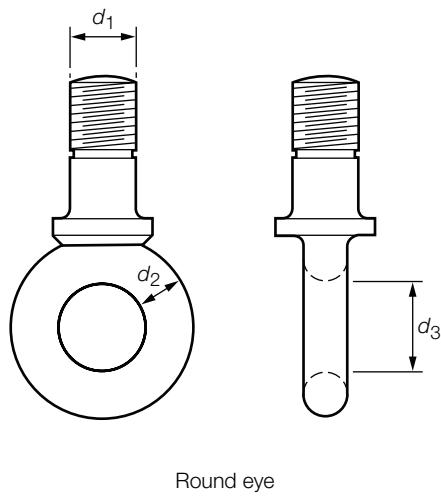
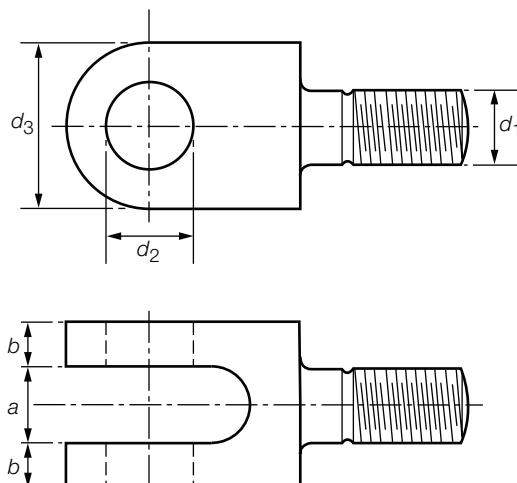


Fig. 6.5.4 Round the oval eyes

Fittings, Loose Gear and Ropes**Chapter 6**

Section 5

**Fig. 6.5.6 Lug fitting****Table 6.5.12 Swivels and eyes**

Item	Safe working load, in tonnes
Swivel bow piece	$\left(\frac{c d_1^3}{a + 0,4d_1} \right) \left(1,75 + \frac{a + d_1}{b + d_1} \right)$ where $b < 2,55d_1$ this value is to be multiplied by $0,22 \left(2 + \frac{b}{d_1} \right)$
Round eye	$\frac{c d_2^3}{d_3 + 0,4d_2}$ where $d_3 < 2,55d_2$ this value is to be multiplied by $0,22 \left(\frac{d_3}{d_2} + 2 \right)$
Oval eye	$\frac{c d_4^3}{g + 0,4d_4}$ where $b < 2,55d_4$ this value is to be multiplied by $0,22 \left(\frac{b}{d_4} + 2 \right)$
Triangular eye	Top $0,0069e f$ Side $\frac{0,0138h g^2 K}{m}$ Bottom $\frac{0,0138k j^2 K}{m}$
Lugs	$0,0125b (d_3 - d_2)$
Shank	$c d_1^2$
NOTES	
1.	All dimensions are given in millimetres and are illustrated in Fig. 6.5.3 to 6.5.6.
2.	Values of c and K are given in Tables 6.5.13 and 6.5.14 respectively.

Table 6.5.13 Values of c for swivel and eyes

Item	c	
	Mild steel	High tensile steel
Swivel bow piece	0,0066	0,0088
Round eye	0,0176	0,0236
Oval eye	0,0057	0,0076
Shank	0,00493	0,00625

NOTE
High tensile steel is defined as steel having a tensile strength not less than 540 N/mm².

Table 6.5.14 Form factors, K

Shape of section	K
Square $H = B$	1,00
Circular $H = B$	0,66
Rectangular $H = 0,75B$ $H = 0,50B$	0,95 0,90
Radius at intrados and extrados $H = 0,90B$	0,80
Radius at intrados only $H = 0,70B$	0,75
Ellipse $H = 1,25B$ $H = 0,75B$ $H = 0,50B$	0,66 0,65 0,64
Semi-circle $H = 0,50B$	0,64

NOTE
Values for intermediate shapes may be obtained by interpolation.

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Table 6.5.15 Safe working load of chain

Item and material	Safe working load, in tonnes
Short link	
Mild steel	$0,0094d_2$
High tensile steel	$0,0125d_2$
ISO Grade 40	$0,0161d_2$
Long link	
Mild steel	$0,0063d_2$
High tensile steel	$0,00825d_2$

NOTES

1. Where d is the nominal diameter of the chain, in mm.
2. ISO Grade 40 chain is to comply with the requirements of ISO/R 1834, 1835 and 1836 as appropriate.

Table 6.5.16 Safe working load of links and rings

Item	Safe working load, in tonnes
Swivel bow piece	$\left(\frac{c d^3}{a + 0,4d} \right) \left(1,75 + \frac{a + d}{b + d} \right)$ where $b < 2,55d$, this value is to be multiplied by $0,22 \left(2 + \frac{b}{d} \right)$
Rings	$\left(\frac{c d^3}{a + 0,4d} \right)$ where $a < 2,55d$, this value is to be multiplied by $0,22 \left(2 + \frac{a}{d} \right)$

NOTES

1. All dimensions are measured in millimetres and are illustrated in Fig. 6.5.7.
2. The value of C is obtained from Table 6.5.17.

Table 6.5.17 Values of c for links and rings

Minimum tensile strength of material, in N/mm ²	Value of c	
	Links	Rings
430	0,0053	0,0116
540	0,0071	0,0155

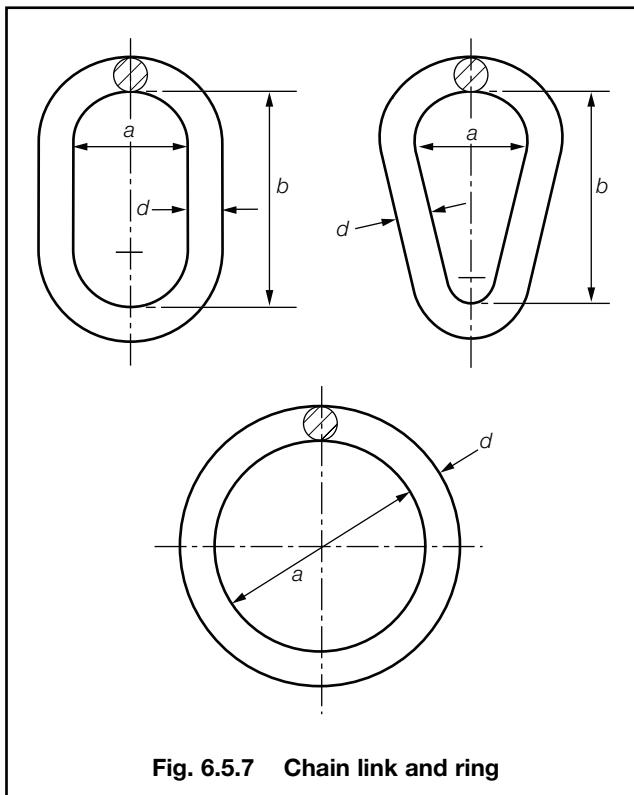


Fig. 6.5.7 Chain link and ring

■ Section 6 Steel wire ropes

6.1 General

6.1.1 Steel wire ropes are generally to comply with the requirements of an international or recognized national standard and are to be suitable for the use for which they are proposed in accordance with manufacturer's recommendations.

6.1.2 Steel wire ropes are to be manufactured at works which have been approved by the Committee. A list of *Approved Manufacturers of Steel Wire Ropes* appears in LR's *Lists of Approved Manufacturers of Materials, Recognized Proving Establishments and Class 1 Welding Firms*. Proposals to use steel wire rope manufactured elsewhere will be specially considered.

6.2 Steel wire for ropes

6.2.1 The wire used in the manufacture of rope is to be drawn from steel manufactured by an approved process. It is to be of homogeneous quality and consistent strength and free from visual defects likely to impair the performance of the rope.

6.2.2 The breaking strength of the wire is to be in accordance with the requirements of Table 6.6.1.

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Table 6.6.1 **Breaking strength of wires**

Nominal strength	Breaking strength, in N/mm ²					
	Lower limit	$d \leq 0,5$	$0,5 < d \leq 1,0$	Upper limit $1,0 < d \leq 1,5$	$1,5 < d \leq 2$	$2 < d$
145	1420	1810	1770	1740	1710	1680
160	1570	1960	1920	1890	1860	1830
180	1770	2160	2120	2090	2060	2030

NOTES

1. The nominal strength, also referred to as the tensile grade, is the lower limit of breaking strength, in N/mm² or kgf/mm².
2. d = the mean diameter of the wire, in mm.

Table 6.6.2 **Types of construction and diameter ranges – Round strand**

Rope designation	Rope construction	Type of main core	Available diameter range, in mm
6-stranded ropes			
6 x 7	6 (6 + 1)	fibre or steel	2 to 36
6 x 19	6 (12 + 6 + 1)	fibre	3 to 44
6 x 37	6 (18 + 12 + 6 + 1)	steel	8 to 48
6 x 19 Seale	6 (9 + 9 + 1)	fibre	6 to 56
6 x 19 Filler	6 (12 + 6F + 6 + 1)	fibre or steel	8 to 36
6 x 26 Warrington-Seale	6 (10 + 5/5 + 5 + 1)	fibre or steel	8 to 36
6 x 31 Warrington-Seale	6 (12 + 6/6 + 6 + 1)	fibre or steel	9 to 40
6 x 36 Warrington-Seale	6 (14 + 7/7 + 7 + 1)	fibre or steel	11 to 40
6 x 41 Warrington-Seale	6 (16 + 8/8 + 8 + 1)	fibre or steel	13 to 56
6 x 12	6 (12 + FC)	fibre	16 to 60
6 x 24	6 (15 + 9 + FC)	fibre	8 to 32
6 x 24	6 (15 + 9 + FC)	fibre	8 to 40
8-stranded ropes			
8 x 19 Seale	8 (9 + 9 + 1)	fibre or steel	8 to 36
8 x 19 Filler	8 (12 + 6F + 6 + 1)	fibre or steel	8 to 36
Multi-strand ropes			
17 x 7	11 (6 + 1) + 6 (6 + 1)	fibre or steel	8 to 28
18 x 7	12 (6 + 1) + 6 (6 + 1)	fibre or steel	12 to 40
34 x 7	17 (6 + 1) + 11 (6 + 1) + 6 (6 + 1)	fibre or steel	12 to 40
36 x 7	18 (6 + 1) + 12 (6 + 1) + 6 (6 + 1)	fibre or steel	12 to 40

6.2.3 The wire is to be galvanized by a hot dip or electrolytic process to give a continuous uniform coating. Consideration will be given however, to the acceptance of non-galvanized and stainless steel wire in certain applications.

6.3 Construction and application

6.3.1 Each strand is to be uniformly made and free from slack wires. Core wires and fibre cores of strands are to be of sufficient size to enable the covering wires to be evenly laid.

6.3.2 The wires in a steel core are normally to be of similar tensile strength to that of the main strand, but wires of a lower tensile strength may be permitted. Fibre cores are to be of a suitable natural or man-made material.

6.3.3 The wire rope is to be uniformly made and the strands are to lie tightly on the core or on the underlying

strands. The free ends of all wire ropes are to be secured against untwisting. Wire ropes are to be thoroughly lubricated.

6.3.4 Wire ropes for running rigging are to be constructed of not less than six strands over a main core. Each strand is, generally, to consist of not less than 19 wires and may have a fibre or a wire core. Where the strand has a fibre core, the wires are to be laid round it in not less than two layers.

6.3.5 Wire ropes for standing rigging, guy pendants and similar applications are generally to be constructed of six strands over a wire core.

6.3.6 Lang's lay rope will not normally be accepted for any part of a ship's cargo handling gear.

6.3.7 Types of construction and diameter ranges of standard round strand ropes are given in Table 6.6.2 and minimum breaking loads for certain ropes are given in Table 6.6.3.

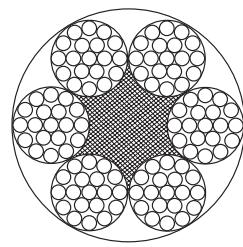
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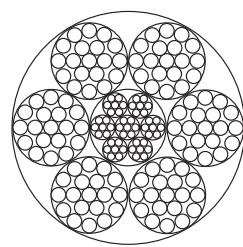
Table 6.6.3 **Breaking loads of steel wire ropes** (see continuation)Wire rope 6 x 7
Construction of the strand: 6 + 1Wire rope 6 x 19
Construction of the strand: 12 + 6 + 1

With fibre core (FC)

Diameter, in mm	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of		
	1420 N/mm ² steel cored	1570 N/mm ² fibre cored	1770 N/mm ² steel cored
8	30,2	32,6	33,4
9	38,2	41,3	42,2
10	47,2	50,9	52,2
11	57,1	61,6	63,1
12	67,9	73,4	75,1
13	79,7	86,1	88,1
14	92,5	99,9	102
16	121	130	134
18	153	165	169
20	189	204	209
22	228	247	252
24	272	293	300
26	319	344	353
28	370	399	409
32	483	522	534
36	611	660	676



With fibre core (FC)

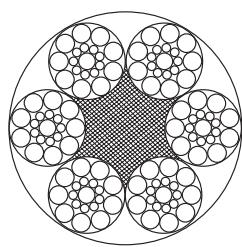


With steel core (WR)

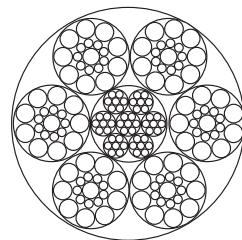
Diameter, in mm	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of		
	1420 N/mm ² steel cored	1570 N/mm ² fibre cored	1770 N/mm ² steel cored
8	8	27,9	30,2
9	9	35,3	38,2
10	10	43,6	47,1
11	11	52,8	57,0
12	12	62,8	67,9
13	13	73,7	79,6
14	14	85,5	92,4
16	16	112	121
18	18	141	153
20	20	175	189
22	22	211	228
24	24	251	271
26	26	295	319
28	28	342	369
32	32	447	483
36	36	566	611
48	48	—	1090

With steel core (WR)

With steel core (WR)

Table 6.6.3 **Breaking loads of steel wire ropes (continued)**Wire rope 6 x 19 Seal
Construction of the strand: 9 + 9 + 1Wire rope 6 x 19 Filler
Construction of the strand: 12 + 6F + 6 + 1

With fibre core (FC)



With steel core (WR)

Diameter, in mm	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of 1770 N/mm ² steel cored		
	1570 N/mm ² fibre cored	1770 N/mm ² steel cored	1770 N/mm ² steel cored
8	33,2	35,9	37,5
9	42,1	45,5	47,4
10	52,0	56,1	58,6
11	62,9	67,9	70,9
12	74,8	80,8	84,3
13	87,8	94,8	99,0
14	102	110	115
16	133	144	150
18	168	182	190
20	208	224	234
22	251	272	283
24	299	323	337
26	351	379	396
28	407	440	459
32	532	575	600
36	673	727	759

With steel core (WR)

With fibre core (FC)

Diameter, in mm	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of 1770 N/mm ² steel cored		
	1570 N/mm ² fibre cored	1770 N/mm ² steel cored	1770 N/mm ² steel cored
8	33,9	36,6	38,3
9	42,9	46,4	48,4
10	53,0	57,3	59,8
11	64,2	69,3	72,3
12	76,3	82,5	86,1
13	89,6	96,8	101
14	104	112	117
16	136	147	153
18	172	186	194
20	212	229	239
22	257	277	289
24	305	330	344
26	358	387	404
28	416	449	469
32	543	586	612
36	687	742	775

With steel core (WR)

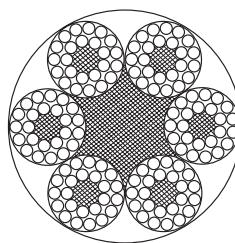
With fibre core (FC)

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Table 6.6.3 **Breaking loads of steel wire ropes** (continued)

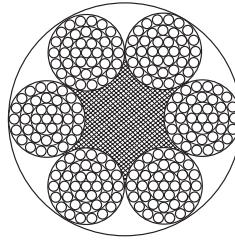
Wire rope 6 x 24
Construction of the strand: 15 + 9 + FC



With fibre core (FC)

Diameter, in mm	1420 N/mm ²	1570 N/mm ²	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of
8	25,5	28,2	286
9	32,2	35,6	339
10	39,8	44,0	419
11	48,1	53,2	507
12	57,3	63,3	603
13	67,2	74,3	707
14	78,0	86,2	820
16	102	113	107
18	129	143	136
20	159	176	167
22	193	213	203
24	229	253	241
26	269	297	267
28	312	345	283
32	407	450	328
36	516	570	429
40	637	704	474

Wire rope 6 x 37
Construction of the strand: 18 + 12 + 6 + 1



With fibre core (FC)

Diameter, in mm	1420 N/mm ²	1570 N/mm ²	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of
8	8	26,8	296
9	9	33,9	375
10	10	41,9	463
11	11	50,7	560
12	12	60,3	666
13	13	70,7	782
14	14	80,0	907
16	16	107	118
18	18	136	150
20	20	167	185
22	22	203	224
24	24	241	267
26	26	283	313
28	28	328	363
32	32	429	474
36	36	543	600
40	40	670	741
	44	810	896
	48	964	1070
	52	1130	1250
	56	1310	1450

Table 6.6.3 Breaking loads of steel wire ropes (continued)

Wire rope 6 x 26 Warrington-Seale
Diameter range: 9 to 40 mm

Construction of the strand: $10 + 5/5 + 5 + 1$

Wire rope 6 x 41 Warrington-Seale
Diameter range: 16 to 60 mm

Construction of the strand: 16 + 8/8 + 8 + 1

With steel core (WR)
With fibre core (FC)

With steel core (WR)
With fibre core (FC)

The diagram illustrates a cross-section of a cable. At the center is a solid black diamond-shaped region representing the conductor. Surrounding the conductor is a layer of small circles, representing the primary insulation. This is followed by a layer of larger circles, representing the secondary insulation. The outermost layer consists of a series of concentric circles, representing the metal shield and outer insulation. The entire structure is enclosed within a large circle.

Wire rope 6 x 31 Warrington-Seale
Diameter range: 11 to 40 mm

Construction of the strand: 12 + 6/6 + 6 + 1
With steel core (WR)

A circular diagram representing a flower with five petals. Each petal is composed of a cluster of small circles. The center of the flower is a square grid of small circles, with a cross-hatched pattern in the middle square.

Diameter, in mm	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of			
	1570 N/mm ² fibre cored	1570 N/mm ² steel cored	1770 N/mm ² fibre cored	1770 N/mm ² steel cored
9	42,0	45,3	47,3	51,1
10	51,8	55,9	58,4	63,1
11	62,7	67,7	70,7	76,3
12	74,6	80,6	84,1	90,8
13	87,5	94,5	98,7	107
14	102	110	114	124
16	133	143	149	161
18	168	181	189	204
20	207	224	234	252
22	251	271	283	305
24	298	322	336	363
26	350	378	395	426
28	406	439	458	494
32	530	573	598	646
36	671	725	757	817
40	829	895	934	1010
44	1000	1080	1130	1220
48	1190	1290	1350	1450
52	1400	1510	1580	1710
56	1620	1750	1830	1980
60	1860	2070	2100	2270

Table 6.6.3 Breaking loads of steel wire ropes (*continued*)

Construction of the strand: $10 + 5/5 + 5 + 1$

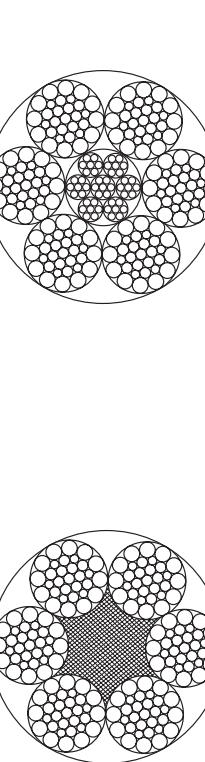
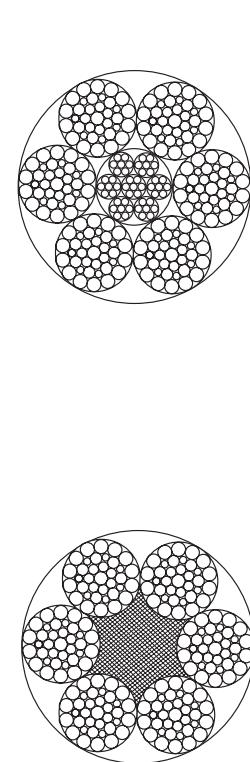
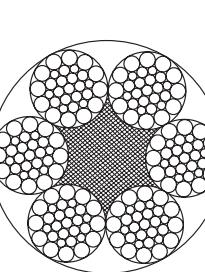
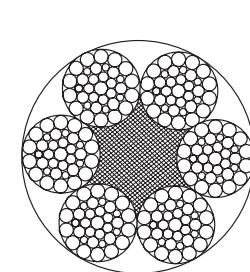
Construction of the strand: 16 + 8/8 + 8 + 1

With steel core (WR)
With fibre core (FC)

With steel core (WR)
With fibre core (FC)

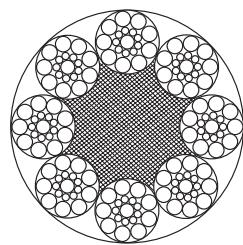
Construction of the strand: 12 + 6/6 + 6 + 1

A circular diagram divided into five equal sectors by a central cross-hatched area. Each sector contains five smaller circles, creating a flower-like pattern.

<p>Wire rope 6 x 31 Warrington-Seale Diameter range: 11 to 40 mm</p>	 <p>Construction of the strand: 12 + 6/6 + 6 + 1</p>
<p>With steel core (WR)</p>	 <p>Construction of the strand: 14 + 7/7 + 7 + 1</p>
<p>With fibre core (FC)</p>	
<p>Wire rope 6 x 36 Warrington-Seale Diameter range: 13 to 56 mm</p>	

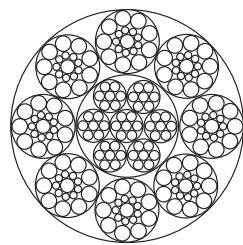
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Table 6.6.3 **Breaking loads of steel wire ropes (conclusion)**Wire rope 8 x 19 Seale
Construction of the strand: 9 + 9 + 1

Wire rope 8 x 19 Seale

Construction of the strand: 9 + 9 + 1



With fibre core (FC)

With steel core (WR)

With fibre core (FC)

With steel core (WR)

Diameter, in mm	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of		1770 N/mm ² steel cored	1570 N/mm ² steel cored	Diameter, in mm	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of	
	1570 N/mm ² steel cored	fibre cored				1770 N/mm ² steel cored	fibre cored
8	28,8	34,0	32,5	38,4	8	29,5	34,8
9	36,5	43,1	41,1	48,5	9	37,3	44,1
10	45,1	53,2	50,8	59,9	10	46,1	54,4
11	54,5	64,3	61,5	72,5	11	55,8	65,8
12	64,9	76,6	73,2	86,3	12	66,4	78,3
13	76,1	89,8	85,9	101	13	77,9	91,9
14	88,3	104	99,6	117	14	90,3	107
16	115	136	130	153	16	118	139
18	146	172	165	194	18	149	176
20	180	213	203	240	20	184	218
22	218	257	246	290	22	223	263
24	260	306	293	345	24	266	313
26	305	359	343	405	26	312	368
28	353	417	398	470	28	361	426
32	461	544	520	614	32	472	557
36	584	689	658	777	36	597	705

With fibre core (FC)

With steel core (WR)

With fibre core (FC)

With steel core (WR)

Diameter, in mm	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of		1770 N/mm ² steel cored	1570 N/mm ² steel cored	Diameter, in mm	Minimum breaking load of the rope, in kN, corresponding to a tensile grade of the wires of	
	1570 N/mm ² steel cored	fibre cored				1770 N/mm ² steel cored	fibre cored
8	28,8	34,0	32,5	38,4	8	29,5	34,8
9	36,5	43,1	41,1	48,5	9	37,3	44,1
10	45,1	53,2	50,8	59,9	10	46,1	54,4
11	54,5	64,3	61,5	72,5	11	55,8	65,8
12	64,9	76,6	73,2	86,3	12	66,4	78,3
13	76,1	89,8	85,9	101	13	77,9	91,9
14	88,3	104	99,6	117	14	90,3	107
16	115	136	130	153	16	118	139
18	146	172	165	194	18	149	176
20	180	213	203	240	20	184	218
22	218	257	246	290	22	223	263
24	260	306	293	345	24	266	313
26	305	359	343	405	26	312	368
28	353	417	398	470	28	361	426
32	461	544	520	614	32	472	557
36	584	689	658	777	36	597	705

With fibre core (FC)

With steel core (WR)

With fibre core (FC)

With steel core (WR)

With fibre core (FC)

With steel core (WR)

6.3.8 Consideration will be given to the use of other constructions and nominal strengths and to the requirements for particular applications.

6.4 Splicing and terminal connections

6.4.1 The lengthening by splicing of ropes for standing or running rigging is not permitted.

6.4.2 The following methods of forming eye or loop splices are acceptable:

- (a) Not less than three tucks with each whole strand of the rope and not less than two tucks with one half of the wires cut from each strand, in all cases the strands to be tucked against the lay of the rope.
- (b) Four tucks with the whole strands of the rope and one tuck with each alternate strand of the rope, made over and under against the lay of the rope.
- (c) A Liverpool type splice, having at least six tucks with each strand, is only to be used where the wire rope is not subject to twisting, i.e. on span tackles, guys and pendants.

Other forms of splice will be accepted provided they can be shown to be as efficient, from all aspects, as those described above.

6.4.3 As an alternative to splicing, approved clips, clamps, sockets or other type of terminal connections may be used. Such connections are to be approved as required by Ch 9,1.3.6 and 1.3.7.

■ Section 7

Fibre ropes

7.1 General

7.1.1 Natural and man-made fibre ropes are to comply with the requirements of an international or recognized national standard and are to be suitable for the use for which they are proposed.

7.1.2 Ropes may be manufactured from one of the following materials:

<u>Natural fibre</u>	<u>Man-made fibre</u>
Hemp	Polyester
Manila	Polyamide (nylon)
Sisal	Polypropylene
	Polyethylene

Proposals to use other materials will be specially considered.

7.1.3 In general, each length of rope is to be manufactured from only one type of natural or man-made fibre. The fibre is to be long staple or continuous multi-filament, unadulterated and free from defects. Proposals to use combination of materials or other types of fibre will be specially considered.

7.1.4 Ropes are generally to be 3-strand (plain or hawser laid) but other constructions will be specially considered.

7.1.5 Weighting and loading matter is not to be added and any added lubricant is to be kept to the minimum. Any rot-proofing or water repellancy treatment is not to be deleterious to the fibre nor is it to add to the weight or reduce the strength of the rope.

7.1.6 Man-made fibres are to be adequately stabilized against degradation by ultraviolet light.

7.2 Application

7.2.1 Minimum breaking loads of natural fibre ropes are given to Table 6.7.1 and of man-made fibre ropes in Table 6.7.2. Attention is drawn, however, to the fact that the strength of man-made fibre ropes may vary appreciably between different manufacturers.

7.2.2 Fibre ropes are not generally acceptable in the systems covered by this Code except for the following applications:

- Derrick systems:
Slewing guys tackles (but not pendants) where the SWL of the guy does not exceed 4,0 t.
Boom head guys in union purchase rigs.
- Launch and recovery systems for diving operations:
Proposals for the use of synthetic fibre ropes for lifting purposes will be considered.

Table 6.7.1 Breaking loads of natural fibre ropes (3 strand)

Diameter	Size of rope	Sisal	Manilla Grade 1	Hemp
mm	mm	kN	kN	kN
16	51	18,0	20,3	17,0
18	57	21,4	24,4	22,5
20	63	28,5	32,5	26,5
22	69	34,0	38,6	31,5
24	76	40,7	45,7	37,5
28	88	53,3	61,0	50,5
32	101	68,8	79,0	65,0
36	113	87,0	96,5	81,5
40	126	104,2	119,4	100,0

Table 6.7.2 Breaking loads of man-made fibre ropes (3 strand)

Diameter mm	Size of rope mm Approximate circumference	Man-made fibre			
		Sisal	Polyamide (nylon)	Polyester	Polyethylene
16	51	35,0	53,0	41,0	28,0
18	57	44,5	67,0	51,0	35,0
20	63	53,7	83,0	63,0	43,0
22	69	65,0	100,00	76,0	51,0
24	76	76,0	120,00	91,0	61,0
28	88	101,0	158,0	122,0	80,0
32	101	128,0	200,0	157,0	104,0
36	113	161,0	248,0	193,0	130,0
40	126	194,0	300,0	239,0	156,0

7.3 Slicing and terminal connections

7.3.1 The lengthening of fibre ropes by splicing is not permitted.

7.3.2 Eye splices are to consist of not less than:

- (a) Natural fibre ropes:
Three full tucks and two tucks in which half the fibres in each strand have been cut away.
- (b) Man-made fibre ropes:
Four full tucks and two tucks in which half the fibres in each strand have been cut away. The ends of the strands are to be fused.

Machinery, Electrical Installations and Control Engineering Systems

Chapter 7

Sections 1 & 2

Section

- 1 **Introduction**
- 2 **Mechanical aspects (classification requirements)**
- 3 **Electrical installations**
- 4 **Control engineering systems**
- 5 **Control and supervision of lifts for passengers and crew**
- 6 **Control and supervision of lifting appliances for cargo handling**

■ **Section 1** **Introduction**

1.1 General

1.1.1 This Chapter is applicable to all machinery, electrical installations and control engineering systems used in lifting appliances indicated in Chapter 1. The service category as defined in Chapters 1, 2 and 3 must be clearly stated on all submissions.

1.1.2 For requirements relating to piping systems, see Pt 5, Ch 12, Ch 13 and Ch 14 of the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as the Rules for Ships), as applicable.

1.2 Design criteria for lifting appliance mechanisms

1.2.1 All lifting appliance mechanisms as detailed in 1.1.1 are to be designed to a recognized National or International Standard.

1.2.2 Consideration is to be given during design to the additional loads imposed by dynamic and environmental effects when they affect the machinery.

1.3 Certification of lifting appliances

1.3.1 Lifting mechanisms other than those for mechanical lift docks, and diving systems on diving support vessels may be certified only, see Ch 1,1.2 and 1.4.1(c) of this Chapter.

1.3.2 Where lifting appliances are to be certified only, detailed plans, calculations and specifications of machinery, electrical installations and control engineering systems will not normally be required to be submitted for approval.

1.3.3 Certification will normally be on the basis of a proof test and examination during commissioning as specified in Chapter 9.

1.4 Classification of lifting appliances

1.4.1 This Chapter will be the basis of approval by LR of the following types of lifting mechanisms:

- (a) Mechanical lift docks.
- (b) Installations for diving systems on diving support vessels.
- (c) Other lifting appliances where classification is requested by the Owner, see Ch 1,1.3.4.

■ **Section 2** **Mechanical aspects (classification requirements)**

2.1 Plans and information to be submitted

2.1.1 Plans required by 2.1.2 to 2.1.4 are to be submitted in triplicate.

2.1.2 Plans and calculations of lifting devices, gearing, shafts, clutches, brakes, ratchet and pawl (not applicable to diving winches), coupling bolts, welded drums, etc., together with the material specifications and physical properties are to be submitted for consideration.

2.1.3 A plan of the general arrangement and winch frame is to be submitted.

2.1.4 Diagrammatic plans of the hydraulic and compressed air systems, where fitted, together with specifications of components are to be submitted for consideration.

2.1.5 The design criteria are to be stated together with details of any torque limiting device.

2.2 Basis of approval of machinery

2.2.1 Approval of machinery for lifting appliances will be based on the requirements of Part 5 of the Rules for Ships, where applicable, with the following modifications:

- (a) Machinery will be dealt with for strength only.
- (b) Machinery in lifting appliances is not necessarily in the same class as marine machinery and the permissible stresses are very much dependent upon type and application of machinery, methods of manufacture and the environmental conditions.
- (c) In dealing with the gearing, only the strength will be required to comply with the requirements for the maximum torque in the system and, if necessary, special consideration will be given to the contemplated service conditions as given in the specification. Alternatively, strength calculations based on a recognized national standard may be submitted for consideration. The calculations should include a root stress concentration factor where applicable.
- (d) The brake should be capable of holding a static load of 1,5 times the rated load of the winch.

Machinery, Electrical Installations and Control Engineering Systems

Chapter 7

Sections 2, 3 & 4

2.2.2 Installations for diving systems require emergency means of retrieval. Consideration is to be given in the design of such systems to national requirements for system redundancy.

2.3 Manufacture of machinery

2.3.1 Machinery is to be constructed, installed and tested under survey.

■ Section 3 Electrical installations

3.1 Classification of lifting appliances

3.1.1 Electrical equipment is to comply with the requirements of a relevant national or international standard, due consideration being given to the environmental conditions envisaged, e.g., in areas of high ambient temperature, de-rating may be necessary.

3.1.2 Installations are to be designed in accordance with Pt 6, Ch 2 of the Rules for Ships or with a recognized National or International Standard or Code of Practice.

3.1.3 All electrical equipment is to be installed and tested to the Surveyor's satisfaction. Tests shall include the measurement of insulation resistance and checks for the correct operation of all protective devices and interlocks fitted.

3.1.4 When the lifting appliance to be classed is a mechanical lift dock, the following plans and particulars are to be submitted, in triplicate, for consideration:

- (a) Arrangement plan and circuit diagram of switchboard(s).
- (b) Diagram of wiring system including cable size, type of insulation, normal working current in the circuits and the capacity, type and make of protective devices.
- (c) Calculations of short circuit currents at main busbars, sub-switchboard busbars and the secondary side of transformers.

3.2 Certification of lifting appliances

3.2.1 The electrical equipment is to be examined and tested for compliance with the appropriate National or International Standard. Tests shall include the measurement of insulation resistance and checks for the correct operation of all protective devices and interlocks fitted.

3.3 Classification of existing lifting appliances

3.3.1 The electrical equipment is to be examined and tested as required by Chapter 9.

■ Section 4 Control engineering systems

4.1 General

4.1.1 The requirements of Sections 4, 5 and 6 apply to all permanently installed, power operated, lifting appliances specified in 4.2.3 which are intended to be classed. Where applicable, the relevant requirements for control, alarm and safety systems as stated in Pt 6, Ch 1,1 and Pt 6, Ch 1,2 of the Rules for Ships are to be complied with.

4.1.2 Where certification of a lifting appliance, as specified in 1.3, is required, the equipment is to be examined and tested under working conditions for compliance with the appropriate national or international standard. Plans for control systems are not required to be submitted.

4.2 Plans

4.2.1 Plans required by 4.2.2 and 4.2.3 are to be submitted in triplicate.

4.2.2 Where control, alarm, or safety systems are intended for the lifting appliances listed in 4.2.3, the following are to be submitted:

- General arrangement of the lifting installation.
- General arrangement of the control station and/or control cabinet(s).
- Details of operating medium, i.e. pneumatic, hydraulic or electric, including power packs and standby sources of power.
- Description of operation with explanatory diagrams.
- Schematic diagrams of control circuits, interlocks and alarm system.
- Details of safety devices including securing and latching arrangements.

4.2.3 Plans for the control, alarm, and safety systems of the following lifting appliances are to be submitted:

- Lifts for passengers and crew.
- Lifts and ramps for cargo handling.
- Derrick winches.
- Derrick cranes.
- Mechanical lift docks.

4.3 Survey during construction

4.3.1 Control engineering systems including alarms and safeguards are to be tested to demonstrate that they are in good working order.

4.4 Classification of existing lifting appliances

4.4.1 The control engineering systems are to be examined and tested in accordance with the requirements of 4.3.1.

Machinery, Electrical Installations and Control Engineering Systems

Chapter 7

Sections 5 & 6

■ Section 5

Control and supervision of lifts for passengers and crew

5.1 General

5.1.1 Alarms and safeguards are indicated in 5.2. Alternative arrangements which provide equivalent safeguards will be considered.

5.1.2 Control engineering equipment is to be capable of satisfactory operation when subject to a pitch or roll of 10° when lifting appliances are in operation. When lifting appliances are stopped, control engineering equipment is to withstand an inclination of 22,5° irrespective of location.

5.2 Alarms and safeguards

5.2.1 Means are to be provided to ensure safe and effective control of speed, direction and stopping of the lift car.

5.2.2 Interlocks are to be provided to prevent activation of the control and drive circuits when:

- (a) car doors or parts thereof are not closed, or
- (b) shaft access doors or parts thereof are not closed.

5.2.3 Power operated bi-parting entrances are to be fitted with protective devices to prevent injury to personnel or passengers and are to comply with the following:

- (a) They are to be fitted to the leading edge of each car and landing door panel.
- (b) They are to extend the full height of the entrance, commencing 25 mm above sills.
- (c) The force to operate the protective devices is not to exceed 14,7 N (1,5 kgf).
- (d) The protective devices are to operate immediately a leading edge is obstructed.

5.2.4 Manual single sliding entrances to the lift car and lift trunk of the concertina or telescopic type are to be fitted with means to prevent slamming.

5.2.5 In addition to the normal upper and lower landing stop controls, independent means are to be provided to stop the lift in the event of top or bottom overrun.

5.2.6 Lifts for passenger ships are to be arranged so that they deck automatically and the doors open in the event of a main power failure. Sequential emergency decking of the passenger lift cars is permitted.

5.2.7 A safety device is to be fitted on the lift car and any counterweight to stop and hold their positions in the event of overspeed or failure of suspension ropes or their fastenings.

5.2.8 A safety device is to be fitted which will stop and hold the position of the lift car and any counterweight in the event of slack suspension ropes.

5.2.9 Means are to be provided to prevent the lift from being operated when the emergency escape hatch is open. The hatch is to be fitted with a key switch or equivalent to prevent accidental closure reactivating the control system.

5.2.10 The lift car is to be provided with an alarm, or telephone, or equivalent means of communication.

5.2.11 A landing indicator is to be provided within the car and outside each entrance.

5.2.12 Means are to be provided to enable the lift car to be raised or lowered manually in the event of power failure. The direction of the lift car travel is to be clearly indicated at the manual control position.

5.2.13 Emergency lighting is to be provided in the lift car, lift motor room, trunk access points and lift trunk. This emergency lighting is to be switched on automatically if the normal supply of electric power fails.

■ Section 6

Control and supervision of lifting appliances for cargo handling

6.1 General

6.1.1 Lifting appliances for cargo handling as specified in 4.2.3 are to be provided with the controls, alarms and safety arrangements required by this Section as appropriate. Alternative arrangements which provide equivalent safeguards will be considered.

6.1.2 Means are to be provided to ensure safe and effective control of speed, direction and stopping of the lifting appliance or ramp.

6.1.3 Each control station is to be provided with means such that the operating area of the lifting appliance and the load being lifted can be observed.

6.1.4 An emergency stop, independent of the controls required by 6.1.2, is to be provided at each control station to stop the motion of the lifting appliances in an emergency. This emergency stop is to be clearly identified and suitably protected to prevent inadvertent operation.

6.1.5 An alarm is to operate in the event of failure of the operating power and means are to be provided to automatically hold the lifting appliance and load in position.

6.1.6 Indication of the operational status of running and standby machinery, if fitted, is to be provided at each control station.

Machinery, Electrical Installations and Control Engineering Systems

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Section 6

6.2 Lifts and ramps

6.2.1 Arrangements are to be provided to prevent activation of the control and drive circuits when:

- (a) Any covers are not retracted.
- (b) The lift is overloaded.
- (c) Vehicle barriers are not closed.

6.2.2 Continuous audible and visual warning is to be given within the operational area during operation of the lift or ramp.

6.2.3 Where a lift or ramp is secured by retractable locks, means are to be provided to ensure that power is not disconnected until all locks have been engaged, and descent is not possible until all locks have been disengaged.

6.2.4 Where a quayside access ramp is fitted in addition to a stern door, the ramp is to be less than 10° to the horizontal before opening or closing of the stern door.

6.2.5 The maximum inclination of the access ramp when in its operating position is not to exceed a predetermined angle from the horizontal and an alarm is to operate should this maximum permitted angle be exceeded.

6.2.6 Where remotely controlled locks are used, alternative means are to be provided to secure the lift or ramp in the event of failure of the lock controls or latching mechanism.

6.2.7 A continuous safety trip wire or equivalent is to be fitted beneath sides and ends of cargo lift platforms, and beneath sides and ends of the deck openings. Means are to be provided to automatically stop and hold the lift platform in position immediately the trip is operated.

6.3 Mechanical lift docks

6.3.1 Means are to be provided to indicate at each control station that the motion of the dock platform is maintained in the horizontal plane. An alarm is to give warning in the event that tilt or skew of the dock exceeds a pre-determined limit.

6.3.2 In addition to the normal quay level stop units, independent means are to be provided to automatically stop the lift dock movement in the event of upper or lower overrun.

6.3.3 Where multiple winches or jacks are employed, means are to be provided to:

- (a) Synchronize their operation.
- (b) Display the load on individual units at each control station.

6.3.4 The total load on the dock is to be displayed at each control station.

6.3.5 Means are to be provided to automatically hold the dock platform in position and operate an alarm in the event of a slack hoisting rope or chain.

6.3.6 Where a dock is secured by retractable locks, pawls or latches, means are to be provided to ensure that power is not disconnected until all locks, pawls or latches have been engaged, and descent is not possible until all locks, pawls or latches have been disengaged.

6.4 Derrick winches

6.4.1 Where a speed change gear is fitted and the hoisting drum is free to rotate when the gear is in the neutral position, means are to be provided to prevent the gear accidentally disengaging during operation. An automatically applied brake is to operate on the drum side of the change gear when neutral is selected.

6.4.2 Where a single motor is employed to position both the jib and the load, means are to be provided to interlock the jib when the motor is being used for hoisting.

6.5 Cranes

6.5.1 Means are to be provided for the control of hoisting, luffing angle, slewing angle and the positioning of travelling cranes as applicable.

6.5.2 Means are to be provided for emergency operation, to enable any load to be safely lowered and positioned.

6.5.3 Protective devices are to be provided, as applicable, to operate alarms, automatically cut off operating power and hold the crane and load in position in the event of a failure of the operating controls for the following:

- (a) Hoist travel.
- (b) Hoist speed.
- (c) Luffing angles.
- (d) Slewing angles.
- (e) Travel of crane along its track.
- (f) Longitudinal and transverse movement of the trolley on its gantry.

6.5.4 For variable load/radius cranes, a load indicator which automatically displays a maximum safe load at a given radius is to be fitted. An alarm is to operate when the load reaches 95 per cent of the SWL and at 110 per cent of the SWL the operating power is to be automatically cut off.

6.5.5 Slack rope switches are to be fitted to each rope system. A suitable time delay may be fitted when operating conditions necessitate this feature. Operation of a slack rope switch is to initiate an alarm, automatically cut off the operating power and hold the crane and any load in position.

6.5.6 Where controls are located on the crane mast, means are to be provided to enable the operator to summon help in an emergency.

6.5.7 In the case of travelling cranes, a continuous audible warning is to be given within the operational area when the crane is to move/is moving along its track.

6.5.8 In the case of offshore and floating cranes, the following is to be provided:

- (a) A wind speed indicator and alarm when wind speed exceeds a predetermined limit for a given time.
- (b) Crane level indication with operating limits (when conditions of list or trim are specified).
- (c) Means of communication between the crane operator and the signalman such that control of the crane is not impaired.
- (d) A hook load indicator.

Materials

Chapter 8

Sections 1, 2 & 3

Section

- 1 **General requirements**
- 2 **Materials to ship classification requirements**
- 3 **Materials to national or proprietary standards**

■ Section 1 **General requirements**

1.1 Scope

1.1.1 Materials used for the construction, or repair, of lifting appliances are to be manufactured and tested in accordance with the general procedures given in this Chapter.

1.1.2 Detailed requirements for the testing and inspection of steel wire rope and fibre rope are given in Chapter 6.

1.1.3 Proposals to use synthetic materials are to be submitted for consideration.

1.1.4 Provision is made in this Chapter for material to be manufactured, tested and inspected according to the following procedures:

- (a) To ship classification requirements.
- (b) To approved national or proprietary standards when ship classification requirements are not specified.

1.1.5 The inspection procedures for each application are defined according to 1.1.4(a) or (b) in the relevant Chapter of this Code dealing with design and construction.

1.1.6 The material properties are to comply with the requirements given in the relevant Chapter dealing with design and/or shown on the approved plan.

■ Section 2 **Materials to ship classification requirements**

2.1 Manufacture, testing and inspection

2.1.1 Materials which are required to comply with ship classification requirements, are to be manufactured, tested and inspected in accordance with the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials).

2.1.2 The material is to be manufactured at a works which has been approved by the Committee for the type of product and grade of material to be supplied.

2.1.3 The mechanical test samples are to be selected and the tests witnessed by the Surveyors. The test results are to comply with the requirements for the grade of material specified by this Code.

2.1.4 The material is to be identified to documents signed by LR's Surveyors certifying compliance with the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as the Rules for Ships).

2.2 Alternative specifications

2.2.1 As an alternative to 2.1.1, and subject to agreement, materials which comply with Section 3 may be accepted provided that these specifications give reasonable equivalence to, and the survey is carried out in accordance with the Rules for Materials.

■ Section 3 **Materials to national or proprietary standards**

3.1 General

3.1.1 When the relevant Chapter of this Code permits the use of material supplied to an approved national or proprietary standard as defined in 1.1.4(b) then the general requirements and procedures given in this Section are to be applied as appropriate for the material and product.

3.2 Manufacture

3.2.1 Steel is to be manufactured by the open hearth, electric or one of the basic oxygen processes. The acceptance of steel made by any other process will be subject to special consideration.

3.3 Chemical composition

3.3.1 The chemical composition is to be suitable for the intended method of construction and service conditions. In general, it is to be similar to relevant requirements in the Rules for Materials. Final acceptance is to be based on the reported cast analysis of the material supplied or on the results of check analysis, see 3.5.2.

3.4 Mechanical properties

3.4.1 The mechanical properties are to comply with the requirements given in the relevant Chapter of this Code and on the approved plan. The specified elongation and impact test values are to be similar to the requirements given in the Rules for Materials for equivalent tensile strength values and related grades.

Materials

Chapter 8

Section 3

3.4.2 The manufacturer's certificate of test will be accepted unless otherwise specified and subject to the provisions of 3.5.

3.5 Testing

3.5.1 Check tests may be required at the discretion of the Surveyor.

3.5.2 In general, the manufacturer's chemical analysis will be accepted but may be subject to occasional independent checks if required by the Surveyor.

3.5.3 When mechanical check tests are required, the specified tests are to be carried out using machines of approved types which are maintained in a satisfactory and accurate condition.

3.6 Inspection

3.6.1 Surface inspection and verification of dimensions are the responsibility of the steelsmith and are to be carried out on all material prior to despatch. Acceptance by the Surveyors of material later found to be defective shall not absolve the steelsmith from this responsibility.

3.6.2 Non-destructive examination of materials is not required for acceptance purposes, unless otherwise agreed. Manufacturers are however, expected to employ suitable methods of non-destructive examination for the general maintenance of quality standards.

3.7 Rectification of defects

3.7.1 In all cases, the removal of defects, and repair by welding where appropriate, are to be carried out to the satisfaction of the Surveyors.

3.7.2 Surface imperfections may be removed by mechanical means as agreed with the Surveyor. After such treatment the dimensions are to be suitable for the application, and the area is to be proved free from defects and the work is to be completed to the satisfaction of the Surveyor.

3.7.3 For steel plates and sections intended for structural purposes, where surface imperfections are removed by grinding, the thickness in any area is not to be reduced to less than 93 per cent of the nominal thickness and in no case by more than 3,0 mm.

3.7.4 For steel castings, flame scarfing or arc-air gouging may be used provided that pre-heating is used where necessary, the surfaces of the resulting depression are subsequently ground smooth and complete elimination of the defective material is confirmed by adequate non-destructive examination.

3.7.5 Repair by welding is not to be carried out without the agreement of the Surveyors before the work is commenced.

3.7.6 The complete removal of all defects is to be proved by suitable non-destructive examinations and the area is to be suitably prepared for welding.

3.7.7 Welding is to be carried out by an approved procedure which is to include the selection of suitable welding consumables, pre-heating and post weld heat treatment as may be necessary because of the chemical composition or the dimensions of the weld repairs. The repair is to be carried out by qualified welders under adequate supervision.

3.7.8 On completion of welding and heat treatment, the area is to be examined by suitable non-destructive techniques.

3.8 Certification and identification

3.8.1 A manufacturer's certificate of test is to be supplied and all material is to be identified to the satisfaction of the Surveyors.

Testing, Marking and Survey Requirements

Chapter 9

Section 1

Section

1 Testing

2 Marking

3 Survey requirements

Section 1 Testing

1.1 General

1.1.1 Every lifting appliance is to be tested and thoroughly examined before being taken into use for the first time or after any subsequent alteration or repair which may affect the strength of the appliance, or at certain Periodical Surveys as indicated in Section 3.

1.1.2 Every item of loose gear is to be proof tested and thoroughly examined before being taken into use for the first time or after any subsequent repair or alteration which may affect the strength of the item.

1.1.3 Where testing machines are used to apply test loads, they are to be of a type approved by Lloyd's Register (hereinafter referred to as LR) as suitable for the intended purpose. The machine is to be calibrated biennially by a recognized authority and the accuracy is to be within ± 2 per cent.

1.1.4 Where test weights are used to apply test loads, the weights are to be certified as accurate to within ± 2 per cent.

1.1.5 Suitable precautions are to be taken before commencing the test to ensure the stability of the ship and the adequacy of the supporting structure to bear the test loads.

1.1.6 Measures are to be taken to ensure that the appliance can be controlled during the test and to avoid injury or damage which might occur in the event of failure under load.

1.2 Loose gear

1.2.1 For the purpose of these requirements, loose gear is defined as including:

Hooks	Shackles
Blocks	Swivels
Chains	Rings

and similar items not permanently attached to the lifting appliance. Lifting beams, spreaders, frames and similar items of equipment which are not an integral part of the lifting appliance are also considered as loose gear. Built-in sheaves and blocks and other items permanently attached to the lifting appliance are not considered as loose gear and the test on the complete system 'as rigged' will be accepted as the test on these items.

1.2.2 The proof load applied to each item of loose gear is to be as required by Table 9.1.1 and associated Notes, and illustrated in Fig. 9.1.1.

Table 9.1.1 Proof loads for loose gear

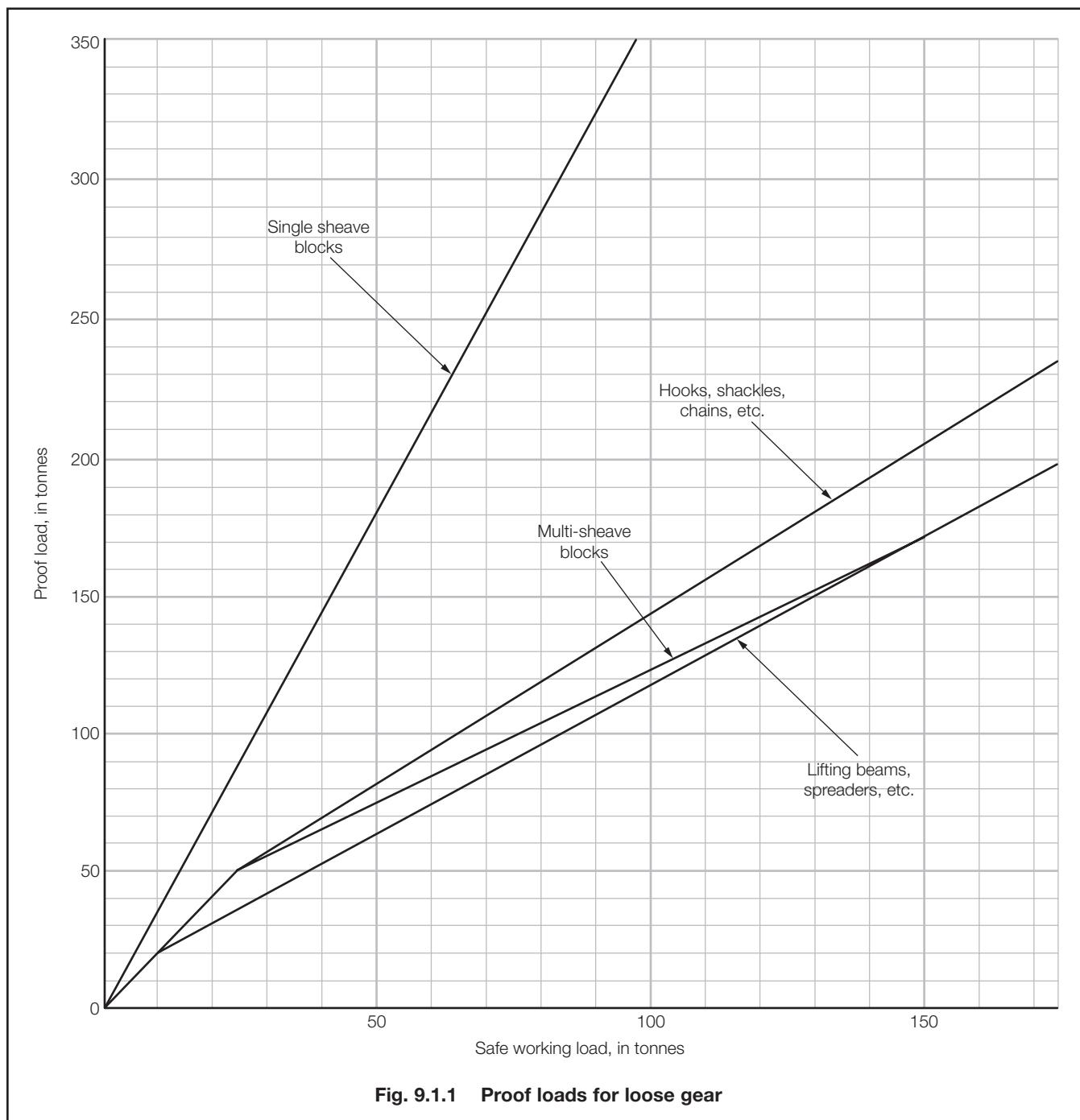
Item	Proof load, in tonnes
Single sheave block	4 x SWL
Multi-sheave blocks:	
SWL \leq 25 t	2 x SWL
25 < SWL \leq 160 t	(0,933 x SWL) + 27
160 < SWL	1,1 x SWL
Hooks, shackles, chains, rings, swivels, etc:	
SWL \leq 25 t	2 x SWL
25 < SWL	(1,22 x SWL) + 20
Lifting beams, spreaders, frames:	
SWL \leq 10 t	2 x SWL
10 < SWL \leq 160 t	(1,04 x SWL) + 9,6
160 < SWL	1,1 x SWL
NOTES	
1. The safe working load for a single sheave block including single sheave blocks with beackets is to be taken as one half of the resultant load on the head fitting.	
2. The safe working load for a multi-sheave block is to be taken as the resultant load on the head fitting.	
3. Where the item is to be used in diving operations, the proof load is to be 1,5 times the proof load value given above for the particular item.	
4. Where the item is to be used for offshore use, the proof loads indicated are to be increased by the ratio $F_h/1,6$ where F_h is derived from Ch 3,3.3.	
5. Proof loads are shown graphically in Fig. 9.1.1.	

1.2.3 In the case of a block, the proof load is to be taken as the resultant load on the head fitting of the block during the test. Where the block is fitted with a becket, the load applied to the becket when proof testing the block will be accepted as the proof test on the becket.

1.2.4 After proof testing, all parts of the block are to be thoroughly examined for deformations, cracks, flaws or other defects and to ensure that head fittings and sheaves rotate freely.

1.2.5 The proof load may be applied to a Ramshorn hook as indicated in Fig. 9.1.2(a) or (b) but in the latter case an additional load of half the proof load is subsequently to be applied as in Fig. 9.1.2(c).

1.2.6 Short and long link chain is to be subjected to a breaking test in addition to the proof test required by 1.2.2. One sample of length 910 mm is to be taken from each length of chain measuring 185 m or less and is to withstand a breaking load of 4 x SWL for the chain.



1.2.7 Where the design of a lifting beam or similar item is such that the load can be lifted and supported in more than one manner, each arrangement is to be separately tested. Hooks, shackles and blocks forming part of the lifting frame are to be separately tested in accordance with Table 9.1.1.

1.2.8 Where the loose gear is for use in an offshore or diving application the selection of the component of loose gear should take account of the higher proof loads required by Notes 3 and 4 of Table 9.1.1.

1.3 Steel wire rope

1.3.1 Steel wire used in the construction of ropes is to be subjected to breaking, torsion and reverse bend tests and to tests for quality and adhesion of the zinc coating in accordance with ISO 2232 *Drawn Wire for General Purpose Non-alloy Steel Wire Ropes – Specifications* or with an acceptable equivalent. Where required, similar tests may be carried out on wires taken from samples of completed ropes.

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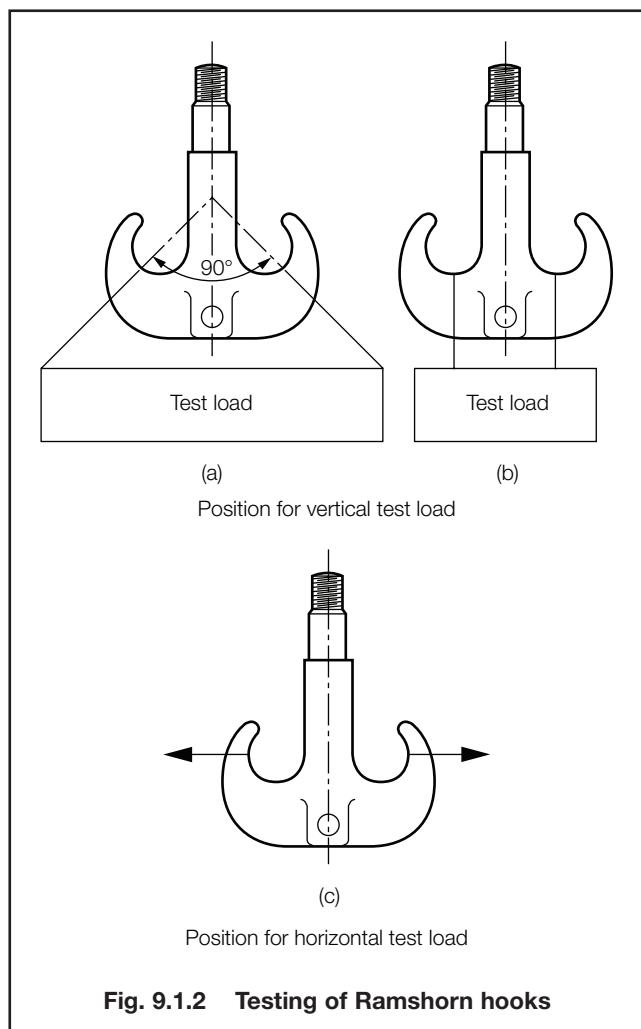


Fig. 9.1.2 Testing of Ramshorn hooks

1.3.2 Steel wire ropes are to be tested to determine the breaking load of the rope. Tests in accordance with international or recognized national standards may be accepted and in this respect attention is drawn to the following international standards:

- ISO 2408 *Steel wire ropes for general purposes – Characteristics*
- ISO 3108 *Steel wire rope for general purposes – Determination of actual breaking load*
- ISO 3178 *Steel wire rope for general purposes – Terms of acceptance*

1.3.3 The breaking load is to be determined by one of the following methods:

- (a) Testing to destruction a sample cut from the completed rope.
- (b) Testing the individual wires to destruction, summing the results and deducting a percentage for laying up. This percentage is to be not less than as given in Table 9.1.2. Manufacturers adopting this method of testing will be required to arrange for occasional tensile tests to destruction to be carried out on completed ropes.

Table 9.1.2 Percentage deduction for laying up

Rope construction	Percentage deduction	
	Fibre core	Steel core
6 x 710	12	17
6 x 19	14	16
6 x 37	17,5	20
6 x 19 Seale	16	—
6 x 19 Filler	16	—
6 x 26 Warrington-Seale	16	—
6 x 31 Warrington-Seale	16	—
6 x 36 Warrington-Seale	16	—
6 x 41 Warrington-Seale	16	—
6 x 12	10	—
6 x 24	13	—
17 x 7 and 18 x 7	22	22
34 x 7 and 36 x 7	25	25

NOTES

1. For construction and breaking loads of ropes, see Chapter 6.
2. WSC = wire strand core
IWRC = independent wire rope core.

1.3.4 Before a test sample is cut from the rope it is to be securely seized or clamped so as to prevent any slackening of wires within the test length. The sample is to be of sufficient length to provide a clear test length in accordance with Table 9.1.3.

Table 9.1.3 Text length for steel wire ropes

Wire rope diameter, d , in mm	Test length, in mm
$d \leq 6$	300
$6 < d \leq 20$	600
$d > 20$	30d but need not exceed 1500 mm

1.3.5 Up to 80 per cent of the nominal breaking load may be applied quickly and thereafter the load is to be applied slowly and steadily until the maximum load is attained. Tests in which a breakage occurs adjacent to the grips may be neglected.

1.3.6 Terminal connections, where used, are to be of a type approved by LR. Initial tests are to be carried out on various sizes of connections to show that the strength of the completed terminal is not less than:

- 95 per cent for ropes up to 50 mm diameter,
- 90 per cent for ropes exceeding 50 mm diameter, of the breaking load of the original wire rope.

After completion each terminal connection is to be proof tested to twice the SWL of the rope.

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1.3.7 Poured zinc sockets do not require to be proof tested provided:

- (a) The termination has been carried out by a competent person in accordance with a recognized procedure and material requirement.
- (b) The sockets are in accordance with a recognized standard and are certified.

1.4 Fibre rope

1.4.1 Fibre ropes are to be tested to determine the breaking load of the rope. Additional tests may be required, particularly in the case of ropes manufactured from man-made materials, in order to establish the suitability of the rope for its intended purpose.

1.4.2 Manufacture and testing are to be in accordance with international or recognized national standards where appropriate.

1.4.3 The breaking load is to be determined by testing to destruction a sample cut from the completed rope. Alternative proposals will, however, be specially considered where a breaking test would be impracticable.

1.4.4 The minimum length of test sample is to be as given in Table 9.1.4. The sample is to be subjected to an initial tensile load as given in Table 9.1.4 and checked for diameter and evenness of lay-up. The load is then to be increased evenly and continuously by stretching the sample at the rate given in Table 9.1.4 until the sample breaks. Tests in which a breakage occurs within 150 mm of the grips may be neglected.

Table 9.1.4 Testing of fibre ropes

Material	Test length, in mm	Initial load, see Note	Speed of loading, in mm/min
Natural fibre	1800	2	150 ± 50
Man-made fibre	900	1	75 ± 25

NOTE
Initial load is expressed as a percentage of the nominal breaking load of the rope.

1.5 Derricks and derrick cranes

1.5.1 Following any preliminary part load tests considered necessary to ensure correct assembly and freedom of operation, each derrick in the system is to be tested with a test load in accordance with Table 9.1.5. The test is to be carried out using certified weights suspended from the cargo hook or lifting attachment, according to a procedure agreed with the Surveyor.

Table 9.1.5 Testing of derricks and cranes

SWL of derrick or crane, in tonnes	Test load, in tonnes
Up to 20 t	1,25 x SWL
Exceeding 20 t but not exceeding 50 t	SWL + 5
Exceeding 50 t	1,1 x SWL

NOTE
Hand operated pulley blocks are to be proof tested to 1,5 x SWL.

1.5.2 During the test, hoisting and slewing operations are to be carried out at slow speed. The load is to be slewed as far as possible in both directions with the derrick boom at the lowest angle to the horizontal for which it has been approved, see Chapter 2.

1.5.3 In addition to verifying the adequacy of the derrick and the support structure, the test is to demonstrate the adequacy of the winch brakes, controls and any overload cut out, safe load indicators, etc. The test is also to demonstrate that the test load can be held stationary when the winch drive is switched off, see also Chapter 7.

1.5.4 Where derricks have been approved for operation in union purchase, they are to be rigged and tested for working both port and starboard sides of the ship. The test is to be carried out for the headroom, runner angle and boom and guy positions for which the rig has been approved with a test load in accordance with Table 9.1.5 for the SWL of the system in union purchase operation.

1.5.5 Following the overload test, the derrick is to be operationally tested with its safe working load. The derrick is to be operated over its full range of positions at normal speeds and it is to be demonstrated that all parts of the system are free to take up their correct positions and that all ropes run freely and reel up correctly on the winch drums.

1.5.6 After testing, the derrick system is to be thoroughly examined for deformations and other defects.

1.5.7 Derrick cranes are to be tested in accordance with 1.5.1 to 1.5.6 with the addition that the derrick crane is to be luffed at slow speed to its maximum operating angle to the horizontal while bearing the full test load.

1.5.8 Where twin span tackles are fitted to derrick cranes of patent type, the manufacturer may be required to demonstrate during testing with the SWL that the derrick boom has adequate stability when in the maximum slewed position for both maximum and minimum luffing angles under the maximum approved angles of heel and trim of the ship.

1.6 Cranes

1.6.1 Following any preliminary part load tests considered necessary to ensure correct assembly and freedom of operation, each crane is to be tested with a test load in accordance with Table 9.1.5. The test is to be carried out using certified weights suspended from the cargo hook or lifting attachment, according to a procedure agreed with the Surveyor.

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1.6.2 During the test the crane is to hoist, slew and luff the test load at slow speed. Gantry and travelling cranes together with their travelling trolleys, where appropriate, are to be traversed slowly over the full length of their track.

1.6.3 In the case of a variable load-radius crane the tests are, generally, to be carried out for the appropriate safe working loads at maximum, minimum and an intermediate radius. Alternative proposals will, however, be considered.

1.6.4 Where the jib length may be increased by the insertion of additional lengths, the crane is to be tested for each jib length.

1.6.5 Where it is not practicable for the crane to raise the full test load, as may be the case for hydraulic cranes, a reduced test load may be accepted but in no case is this to be less than 1,1 x SWL.

1.6.6 Following the overload test, the crane is to be loaded with its safe working load and operated over its full range of speeds in order to demonstrate the operation of the crane and the efficiency of overload and weightload indicators, effectiveness of limit switches, etc.

1.6.7 After testing, the crane is to be thoroughly examined for deformations and other defects.

1.7 Launch and recovery systems for diving operations

1.7.1 Upon completion of preliminary tests necessary to ensure correct assembly and freedom of operation, each lifting appliance used for raising, lowering or transferring manned submersibles or other manned diving systems is to be subjected to the following tests:

- (a) A 'static' load test equivalent to 1,5 x SWL. In the case of cranes or A frames, this load is to be lifted at the maximum and minimum radii or inboard/outboard positions and at an intermediate position.
- (b) A 'dynamic' load test equivalent to 1,1 x SWL. This test is to demonstrate that the hoist brake system is capable of stopping the load whilst being lowered at maximum speed to simulate a power failure.
- (c) An 'operational' load test equivalent to 1,25 x SWL. This test is to be carried out over the full range of operation of the lifting appliance.

1.7.2 Where the diving system is approved for operating in sea states in excess of those described by Beaufort No. 5 (see Ch 3,4.1.1), the test loads indicated in 1.7.1 are to be increased by the ratio $F_h/1,7$ where F_h is derived from Ch 3,3.3.

1.7.3 If testing to values in excess of those defined in 1.7.1 and 1.7.2 is envisaged a review of the launch and recovery system should be undertaken to ensure that overstressing does not occur.

1.7.4 For the purpose of these requirements, the safe working load of the appliance is to be taken as the greater of:

- (a) the maximum in air weight of the diving system, lifting frame and rope when it is at water surface, or
- (b) the total submerged weight of the diving system, lifting frame and rope when it is at its maximum operating depth.

1.7.5 Following the overload test, the lifting appliance is to be loaded with its safe working load and operated over its full range of speeds in order to demonstrate satisfactory operation, efficiency of overload and weightload indicators, effectiveness of limit switches, etc.

1.7.6 After testing, the lifting appliance is to be thoroughly examined for deformations and other defects.

1.7.7 Further tests in accordance with LR's *Rules and Regulations for the Construction and Classification of Submersibles and Diving Systems* (hereinafter referred to as the Rules for Submersibles) may be required and reference should be made to that publication. Where compliance with National Authority Regulations is required, specific reference should be made to the Regulations in case any additional or more onerous test requirements are appropriate.

1.8 Mechanical lift docks

1.8.1 The test requirements for mechanical lift docks are given in Chapter 4.

1.9 Lifts and ramps

1.9.1 Attention is drawn to the existence of statutory requirements of certain National Authorities for the testing of lifts, particularly of passenger lifts.

1.9.2 Each lift is to be tested with its applied or rated load, see Chapter 5, to demonstrate the satisfactory operation of the lift and all control and safety systems.

1.9.3 In addition, after installation and following any major repair, renewal or alteration, each lift is to be subjected to the following tests:

- (a) The brake is to hold the lift with a proof load of 1,25 times the applied or rated load.
- (b) The lift is to be operated through one complete round trip with a proof load of:
 - (i) Passenger lifts: 1,1 times the applied or rated load.
 - (ii) Cargo or vehicle lifts:

Safe working load (SWL)	Test load, in tonnes
Up to 20 t	1,25 x SWL
Exceeding 20 t but not exceeding 50 t	SWL + 5
Exceeding 50 t	1,1 x SWL

1.9.4 Vehicle ramps which may be raised or lowered while loaded are to be tested as for vehicle lifts.

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1.9.5 Vehicle ramps which are raised or lowered only when unloaded are to be tested after installation and following any major repair, renewal or alteration as follows:

- (a) The brake is to hold the ramp in its most unfavourable position while the ramp is subjected to a load of 1,25 times its self weight.
- (b) The ramp is to be placed in its working position and subjected to a test load as given for vehicle lifts in 1.9.3(b).
- (c) The ramp is to be operated through one complete operating cycle, unloaded, using the terminal stops only.

1.10 Re-testing

1.10.1 Re-testing of loose gear is to be carried out in the following circumstances:

- (a) In the absence of an appropriate certificate indicating that the item has previously been tested.
- (b) Following any repair or alteration which may affect the strength of the item.
- (c) As required by the National Administration.

1.10.2 The re-test of loose gear is to be in accordance with 1.2.

1.10.3 Re-testing of derrick systems, derrick cranes and cranes is to be carried out in the following circumstances:

- (a) Following any structural repair, alteration or re-erection of the appliances.
- (b) As part of the Quadrennial Survey requirements in the case of derricks and of every fourth Annual Thorough Survey in the case of cranes and derrick cranes.
- (c) At every 4th or 5th Annual Thorough Survey depending on the requirements of the National Administration.

1.10.4 These tests need not be as extensive as the initial tests but it must be demonstrated that the test load can be raised and lowered. It is preferable also for the derrick or crane to be slewed and luffed during the retest but this may be waived at the discretion of the Surveyor.

1.10.5 Re-testing of union purchase rigs is not essential provided the derrick has been re-tested in single working and special attention is paid to the condition of the preventer guy eyeplate attachment to the deck.

1.10.6 Derricks and cranes having a safe working load not exceeding 15 t may be re-tested using a spring or hydraulic weighing machine provided:

- (a) The machine has an accuracy within ± 2.0 per cent and the load is applied for at least five minutes with the indicator remaining constant.
- (b) The derrick boom is placed in the most onerous certified operating position.
- (c) The support point for the machine is adequately strengthened to avoid overstressing of the supporting structure.

1.10.7 Lifting appliances used for raising, lowering or transferring manned submersibles or other diving systems are to be re-tested annually in accordance with 1.7. Re-testing will also be required following any structural repairs, alterations or re-erection of the appliance.

1.10.8 Lifts and ramps are to be re-tested at every 4th or 5th Annual Thorough Survey, depending on the requirements of the National Administration, and also when repairs or alterations have been carried out affecting the strength of the item. The re-test is to be in accordance with 1.9.3.

■ Section 2 Marking

2.1 General

2.1.1 Each lifting appliance and each item of loose gear is to be clearly and permanently marked with its safe working load, with an identification mark to enable it to be readily related to its appropriate test certificate and with the mark of the Surveyor or manufacturer who carried out the proof test.

2.1.2 In view of the importance of ensuring that each item of loose gear has the correct safe working load for its particular position in the lifting appliance, and to facilitate the ordering of replacements, it is recommended that a Particulars Book or a fully detailed Rigging Plan be kept on board.

2.1.3 It is recommended that the Particulars Book be based upon ISO 2333 *Shipbuilding – Cargo Gear Particulars Book*, which includes a set of forms designed to present the required information in a comprehensive and standardized manner.

2.1.4 It is also recommended that the Rigging Plan should make use of the list of symbols given in ISO 2333 and reproduced as Fig. 9.2.1.

2.2 Loose gear

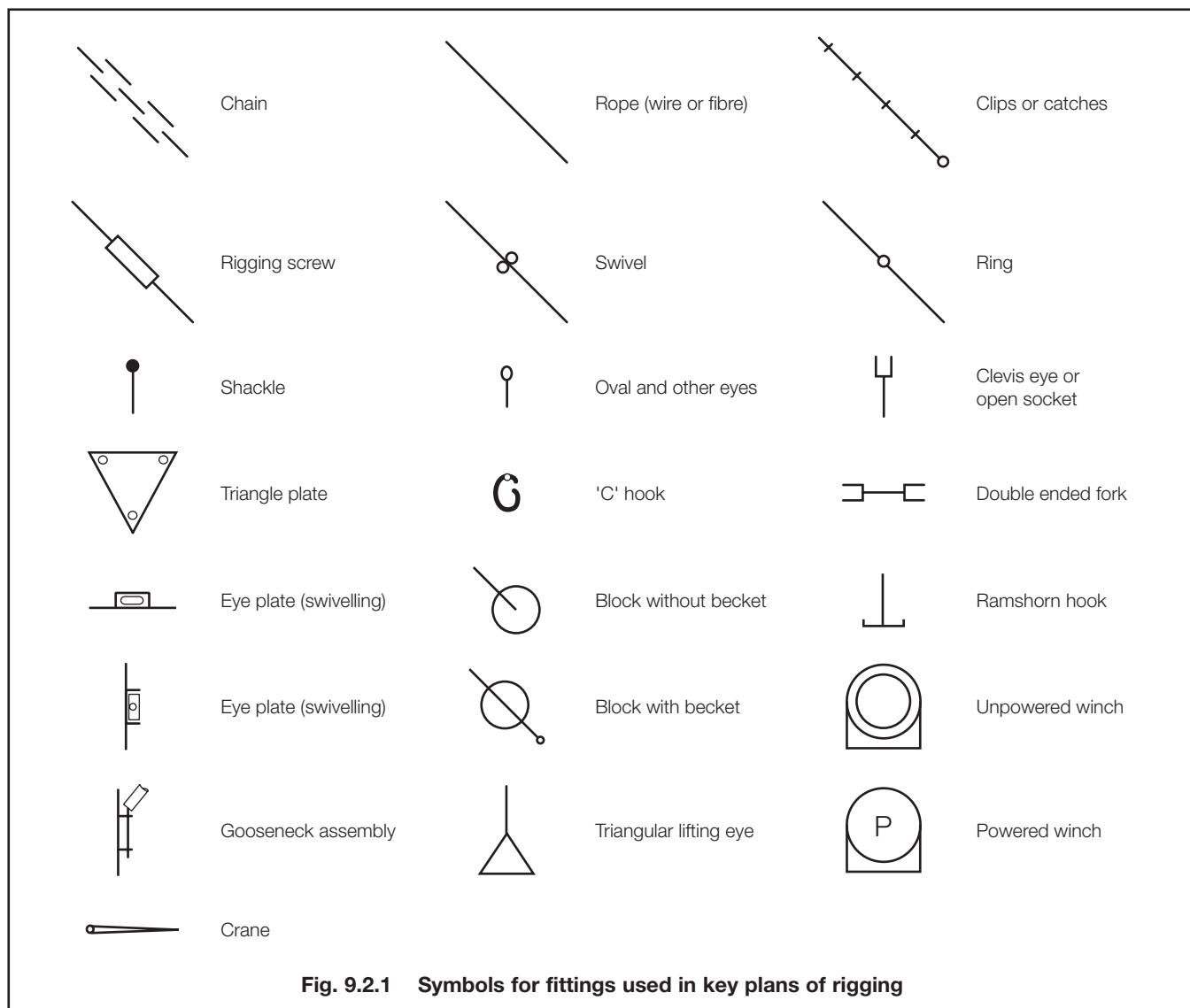
2.2.1 Every item of loose gear, including lifting beams and similar items, is to be marked with:

- (a) The safe working load of the item, in tonnes. For asymmetric lifting beams, the maximum reaction at each lifting point is also to be marked.
- (b) An individual identification mark to relate it to its test certificate.
- (c) A mark indicating the grade of steel in accordance with Table 9.2.1.
- (d) The Surveyor's or manufacturer's stamp.
- (e) For blocks, the maximum rope diameter for which the block is designed.
- (f) For lifting beams and similar items, the tare weight in tonnes.
- (g) Where appropriate, an identification mark corresponding to the position of the item on the ship's Rigging Plan.

2.2.2 Permanent identification marks, or symbols, are to be made with stamps having rounded profiles (low stress stamps). The number of marks on an item is to be kept to the minimum.

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**Fig. 9.2.1 Symbols for fittings used in key plans of rigging****Table 9.2.1 Material quality grade marks**

Quality grade mark	Grade of steel	Ultimate tensile strength, in N/mm ²
L	Mild	300
M	High tensile	400
P	Alloy	500
S	Alloy	630
T	Alloy	800

2.2.3 The use of fractions and oblique strokes is to be avoided and a dot or hyphen is preferable to a dividing line.

Values of SWL are, generally, to be marked to one place of decimals (except for 0,25 and 0,75) up to 100 t and in integers thereafter. The word 'tonnes' may be abbreviated to 't'.

2.2.4 Recommended sizes of marks are given in Table 9.2.2 based on the diameter of the part to be marked or on the SWL of the item as appropriate. Typical arrangements of marks are shown in Fig. 9.2.2.

2.3 Steel wire and fibre ropes

2.3.1 The following information is to be marked on a disc or tally attached to the rope:

- (a) An individual identification mark to relate the rope to its test certificate.
- (b) The Surveyor's or manufacturer's stamp.

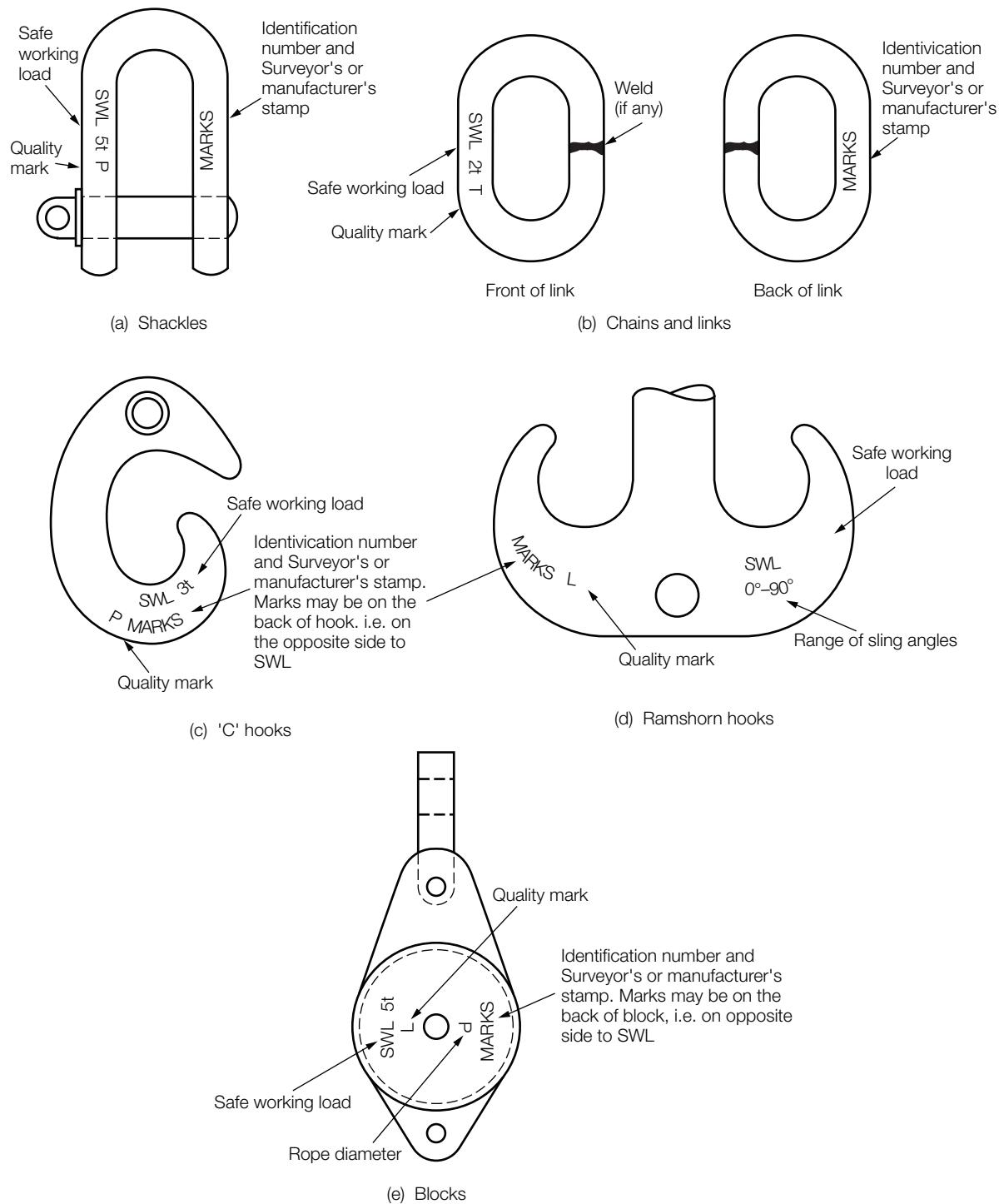
2.3.2 Where the rope is fitted with a ferrule or socket, this is to be marked to relate it to the manufacturer's test certificate. The marks required by 2.3.1 may also be made on the ferrule or socket where appropriate.

2.4 Derricks, cranes and launch and recovery systems for diving operations

2.4.1 Every lifting appliance is to be conspicuously and permanently marked near the heel of the boom, jib or equivalent component with its safe working load and the minimum operating angle or limiting radius as indicated in Table 9.2.3.

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**Fig. 9.2.2 Typical marks for loose gear**

2.4.2 Where more than one method of rig is possible, or, for derricks, where union purchase operation is proposed, the safe working load for each method of rig is to be marked.

2.4.3 The letters and numbers are to be not less than 75 mm high and painted in yellow or white on a dark background or black on a light background.

2.4.4 The heel fitting of the appliance is to be marked with the number of the relative test certificate and with the Surveyor's stamp. The stamps are to have rounded profiles (low stress stamps).

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Table 9.2.2 Size of marks

Item	Diameter of part to be marked, in mm	SWL of item in tonnes	Recommended size of mark, in mm
Chains, links, rings, shackles, eyes (without collar), swivels	Less than 12,5		3,0
	12,5 to 26		4,5
	Over 26		6,0
Eyes (with collar), triangle plates, rope sockets, hooks, blocks		Up to 2	3,0
		2 to 8	4,5
		Over 8	6,0
Lifting beams, spreaders, frames		All	Minimum 75

Table 9.2.3 Typical marks on lifting appliances

Description	Mark
Swinging derrick with boom as normally rigged	SWL 10 t (30°)
Swinging derrick with alternative rig Derricks used in union purchase to be marked on inboard side of boom	SWL 3/10 t (30°) SWL (U) 3 t
Crane of constant capacity over full range of radii	SWL 10 t (4 m/20 m radius)
Crane of variable load/radius characteristics	A plate indicating the characteristics is to be permanently attached to the crane

■ Section 3 Survey requirements

3.1 General

3.1.1 Where LR is requested to issue certification of lifting appliances, plans of the arrangements and scantlings of the installation are to be approved in accordance with the appropriate Chapter of this Code and an Initial Survey of the installation is to be carried out in accordance with 3.2 or 3.3 as appropriate.

3.1.2 Subsequent Periodical Surveys for the maintenance of the validity of the certification are to be carried out at the intervals and in the manner prescribed in 3.4.

3.1.3 Requests from the Owner for the deferment of surveys will be considered and may be permitted in the circumstances given in 3.5.

3.1.4 Surveys for damage to the lifting appliance are to comply with 3.6.

3.1.5 Where the lifting appliances have also been assigned a class in the *Register Book*, the surveys are also to comply with 3.7.

3.1.6 Requests for other surveys not specified above will be specially considered. Such surveys will, generally, be covered by separate instructions since they will normally involve the specific requirements of a National Authority.

3.2 Initial Survey of new installations

3.2.1 Materials used in the construction of the lifting appliance are to be of good quality, free from defects and of specification acceptable to the Committee for the intended purpose. Materials test certificates are to be made available.

3.2.2 The lifting appliance is to be surveyed during construction and the Surveyor is to be satisfied that the primary structural arrangements and workmanship is in accordance with the approved plans. Any details, required for further clarification or certification purposes, not in accordance with the approved plans or otherwise found to be unsatisfactory, are to be rectified.

3.2.3 All welding is to be to the satisfaction of the Surveyor.

3.2.4 Particular attention is to be given to the supporting structure for masts, crane pedestals and runways. It is to be verified that the scantlings and arrangements are in accordance with approved plans.

3.2.5 All loose gear for the installation is to be examined in order to verify that:

- (a) The item has been designed, manufactured and tested in accordance with the requirements of this Code.
- (b) The item is individually marked and certified.
- (c) The item is of the correct SWL for its proposed location in the installation as indicated in the approved plans.

3.2.6 The lifting appliance is to be tested as required by Section 1. Cut outs, controls and similar devices are to function correctly. After testing, the installation including the supporting structure, is to be examined for deformation or distortion to the satisfaction of the Surveyor.

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3.2.7 Works testing of cranes cannot be accepted as an alternative to on board testing.

3.3 Initial Survey of existing installations

3.3.1 Where LR is requested to issue certification either to replace existing certification or because the original certification is lost or no longer valid, the following procedure is to be adopted:

- (a) Plans and information of the scantlings and arrangements of the installation are to be submitted for approval. Where plans are not obtainable, adequate drawings are to be prepared by the Owner from dimensions and scantlings measured on board the ship.
- (b) Certification of all loose gear is to be examined and, where certificates are missing, items are to be proof tested and re-marked.
- (c) A thorough survey of the installation and support structure is to be carried out. This is to be equivalent to a Quadrennial Survey for derricks or a thorough Annual or 6-monthly Survey for other appliances, as applicable.
- (d) The installation is to be tested as required by Section 1.

3.4 Periodical Surveys

3.4.1 It is a statutory requirement of most National Authorities that, following certification at the Initial Survey, the equipment be periodically surveyed to maintain the validity of the certification. The interval between Periodical Surveys is to be not greater than 12 months, see Table 9.3.1. However, the Owner should also ensure that he complies with any statutory requirements in this respect.

3.4.2 The procedure to be adopted at Periodical Surveys is as follows:

- (a) Verification that the existing certification is valid, up to date and issued by a competent authority.
- (b) Survey of the lifting appliance and re-testing where required.
- (c) Endorsement of the Register of Ship's Cargo Gear and Lifting Appliances or equivalent documents and issue of certificates as necessary.

3.4.3 In carrying out the survey of the installation, parts which are found to be worn or corroded to a significant degree are to be replaced or repaired as appropriate. For guidance purposes generally acceptable levels of weardown are given in Table 9.3.2 but earlier repair may be required where the circumstances warrant such action.

3.4.4 The detailed requirements for survey of lifting appliances and associated loose gear are given in the following Tables:

Table 9.3.3	Derrick systems.
Table 9.3.4	Cranes (including derrick cranes) and launch and recovery systems for diving operations.
Table 9.3.5	Cargo lifts and ramps.
Table 9.3.6	Passenger lifts.

Table 9.3.1 Intervals between Periodical Surveys

Lifting appliance	Survey type and interval
Derricks	Annual Thorough Survey
Cranes and derrick cranes	Annual Thorough Survey
Lifting appliances on fixed and mobile offshore installations	Annual Thorough Survey
Lifting appliances on fixed and mobile offshore installations used for manned diving operations	6-monthly thorough survey
Lifting appliances for manned diving systems	6-monthly thorough survey
Lifts – manually operated	Annual Thorough Survey
Lifts – powered	Annual Thorough Survey
Ramps	Annual Thorough Survey
Mechanical lift docks	See Chapter 4

NOTE

Annual Thorough Surveys are to be held once in every 12 month period, unless otherwise stated by the ship's flag administration.

Table 9.3.2 Limits of weardown and corrosion

Item	Limits	Remarks
Structural members	10 per cent maximum at any point, based on the material thickness	—
Loose gear	5 per cent on any diameter 2 per cent on any diameter of a pin in a hole	Item may not be able to sustain the proof load
Wire ropes	5 per cent of broken, worn or corroded wires in any length of ten rope diameters	— Attention is also drawn to the detailed criteria given in ISO 4309 <i>Wire Ropes for Lifting Appliances – Code of Practice for Examination and Discard</i>

3.4.5 In determining the extent of the examination or dismantling, due regard is to be given to the standard of maintenance, state of lubrication and degree of use of the appliance.

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Table 9.3.3 Annual Surveys of derrick systems (see continuation)

Item	Survey
(1) Arrangements	Check that arrangement of loose gear, guys, mast stays, etc., is as shown in Cargo Gear Particulars Book or Rigging Plan
(2) Derrick boom and mast fittings	<ul style="list-style-type: none"> (i) Survey lugs, etc., at derrick head and mast head (ii) Withdraw and survey goosenecks, trunnion fittings, etc., together with their pins (iii) Withdraw other pins and survey mast head span swivels, tumblers, etc. (iv) Check pins for deformation, wear, scoring or other defects (v) Survey independent anchorages for heel blocks (vi) Check efficiency of lubrication to swivels, goosenecks, etc.
(3) Fittings on deck	Survey deck eyeplates, cleats, wire rope stoppers, etc., used in normal working as indicated by the Master or Officer in charge, for wear or deformation. Check weld attaching eyeplates to deck
(4) Derrick boom	<ul style="list-style-type: none"> (i) Survey for corrosion. (Where this is suspected, paint is to be removed as necessary.) Special attention is to be paid to the part of the boom which comes into contact with the crutch or housing (ii) Hammer test boom and, if then considered necessary, check thickness by drilling or other suitable method (iii) Survey for scars or dents and check that boom is not bent (iv) Where appropriate, check condition and free movement of the head and heel fittings. Where considered necessary, the boom is to be manoeuvred through all its working positions
(5) Blocks	<ul style="list-style-type: none"> (i) Blocks to be surveyed. This may be carried out on board the ship provided the necessary facilities are available. Where repair of the block is necessary, it is to be carried out in a properly equipped workshop (ii) Sheaves and pins are to be removed, but sheaves forming an integral part of the derrick boom may be examined <i>in situ</i> (iii) Stress bearing parts of the block, including head fittings, are to be cleaned (the paint being removed where necessary) and surveyed for signs of wear, lack of lubrication or scoring of the rope groove (iv) The nut or collar of the shank or swivel head fittings is to be surveyed to check that it is securely fastened and free from visible defects. The shank should turn freely by hand and wear is not to be excessive. The shank is to be removed if required (v) Cheek and partition plates are to be examined for buckling, distortion or to sharp edges (vi) If the repair affects the strength of the block, or if a certificate of test is not available, the block is to be re-tested and certified (vii) Verify that blocks are of the appropriate safe working load for the position in which they are rigged
(6) Shackles, links, rings, hooks, triangle plates, etc.	<ul style="list-style-type: none"> (i) Examine under proper conditions and check for cracks, deformation, wear, wastage or other defects. Items are to be free from paint, grease, scale, etc. (ii) Confirm that material is recorded on test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel (iii) If deformation of the shackle is found, and re-setting is carried out, the shackle is to be suitably heat treated, re-tested and certified (iv) If the shackle pin is renewed, the whole shackle is to be re-tested and certified
(7) Wire ropes	<ul style="list-style-type: none"> (i) Survey condition of rope (ii) Check for broken, worn or corroded wires. In general, the rope is to be replaced if the number of broken, worn or corroded wires exceeds the limit given in Table 9.3.2 (iii) Survey terminal fittings, splices, etc., with particular attention to broken wires at ferrule connections. Any serving on splices is to be removed for the examination (iv) Liverpool splices are to be rejected on any rope where the ends are not secured against rotation (v) Before re-rigging ensure that the wire rope has been lubricated
(8) Natural and man-made fibre ropes	<ul style="list-style-type: none"> (i) Survey condition of rope (ii) Check for external chafe and cutting and for internal wear between the strands (iii) Check for local or general deterioration of natural fibre ropes due to mildew or rot (iv) Check ropes for chemical attack or other contamination
(9) Chains	<ul style="list-style-type: none"> (i) The chain is to be taken to a suitably equipped workshop for examination and examined after removal of paint, grease, scale, etc., and wire brushing (ii) Check for deformation, wear or other defects. If links require renewal the chain is to be suitably heat treated and re-tested. Replacement links are to be of equivalent material and strength to the original (iii) Confirm that material is recorded on test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel

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Table 9.3.3 Annual Surveys of derrick systems (conclusion)

Item	Survey
(10) Re-test	<ul style="list-style-type: none"> (i) Loose gear is to be proof tested if repairs have been carried out which affect the strength or if certificates are not available (ii) Re-testing of the derrick is necessary at 4/5 yearly intervals as appropriate, and after repairs have been carried out affecting the strength or otherwise as required by the surveyors. (iii) If a component part of the derrick, such as a derrick heel pin, has been replaced, re-testing is not called for if the component has been tested individually to the resultant load which would have been imposed upon it if it had been tested <i>in situ</i> (iv) Where the repaired or renewed item has not been tested, then the derrick is to be re-tested (v) The test is to demonstrate the effectiveness of limit switches, etc.
(11) Masts, derrick posts, guy posts, etc., and structure in way	The Periodical Survey requirements for classification are to be complied with, see Pt 1, Ch 3 of the <i>Rules and Regulations for the Classification of Ships</i> (hereinafter referred to as the Rules for Ships).

Table 9.3.4 Annual Survey of cranes and launch and recovery systems for diving operations (see continuation)

Item	Survey
General note	This producer should, in general, also be applied to derrick cranes
(1) Arrangement	Check reeving arrangement and hoist block assembly as shown in Cargo Gear Particulars Book or manufacturer's manual
(2) Fixed sheaves, blocks, axle pins and housings	<ul style="list-style-type: none"> (i) Determine that the sheaves are free from cracks. The extent of the examination is to be such that a reliable judgement can be made. Depending on access it may be necessary to dismantle the item (ii) Survey rope groove for scoring (iii) Check that lubrication arrangements are in working order (iv) Check anchorage of fixed axle pins (v) Check for free rotation of sheave on axle pin (vi) Check for excessive wear of axle pin and sheave bush. Check condition of housing and separation plates
(3) Jib heel pins	Check lubrication for detrimental wear
(4) Slewing rings for cranes on ships	<ul style="list-style-type: none"> (i) Check lubrication, for tightness of bolts and check that there is not detrimental wear or excessive movement in the ring (ii) Particular attention is to be paid to signs of excessive tolerance (slack) between the inner and outer rings and to signs of wear in the raceways as indicated by the condition of the grease (iii) Additional inspections are to be carried out where these are specified by the crane or slew ring manufacturer
(5) Slewing rings for cranes on offshore installations	<ul style="list-style-type: none"> (i) A visual examination is to be carried out and the bolts hammer tested. The ring is to be checked for evidence of wear or excessive movement. The adequacy of the lubrication system is to be checked (ii) Sample bolts are to be removed annually for examination with regard to stress corrosion cracking (iii) Where the slewing ring was not designed and constructed specifically for offshore service, the bearings are to be exposed for inspection by non-destructive test methods every 36 months (iv) Where the slewing ring was designed and constructed to LR's static and fatigue strength requirements based on type tests; the bearings are to be exposed for inspection by non-destructive test methods as follows: <ul style="list-style-type: none"> For cranes fitted to installations and used during the construction phase and before certification of the platform – 36 months from the commissioning of the crane. For cranes fitted to installations and used only after certification of the platform – 60 months from the commissioning of the crane (v) The interval between subsequent inspections for all types of bearing will be based on the results of these inspections
(6) Wire ropes	<ul style="list-style-type: none"> (i) Survey condition of rope (ii) Check for broken, worn or corroded wires. In general, the rope is to be replaced if the number of broken, worn or corroded wires exceeds the limit given in Table 9.3.2 (iii) Survey terminal fittings, splices, etc., with particular attention to broken wires at ferrule connections. Any serving on splices is to be removed for the examination. (iv) Liverpool splices are to be rejected on any rope where the ends are not secured against rotation (v) Before re-rigging check that the wire rope has been thoroughly lubricated

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Table 9.3.4 Annual Survey of cranes and launch and recovery systems for diving operations (conclusion)

Item	Survey
(7) Structure and general	<ul style="list-style-type: none"> (i) Check bolts for tightness. Where bolts have been replaced, they are to be of the same type and quality as previously fitted (ii) Survey foundation bolts for signs of corrosion (iii) Check welds for cracks (iv) Survey structure for corrosion, removing paint and carrying out hammer tests as necessary. If considered necessary the thickness of structural items is to be checked by drilling or other approved method (v) Check jib, tower, support pedestal, gantry, etc., for any sign of local indentation or unfairness (vi) In the case of travelling cranes, check rails, stops and stowage arrangements
(8) Shackles, links, rings, hooks, etc.	<ul style="list-style-type: none"> (i) Check for cracks, deformation, wear, wastage or other defects. Items are to be free from paint, grease, scale, etc. (ii) Confirm that material is recorded on test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel (iii) If deformation of the shackle is found, and re-setting is carried out, the shackle is to be suitably heat treated, re-tested and certified (iv) If the shackle pin is renewed, the whole shackle is to be re-tested and certified
(9) Chains	<ul style="list-style-type: none"> (i) The chain is to be taken to a suitably equipped workshop for examination and surveyed after removal of all paint, grease, scale, etc., and wire brushing (ii) Check for deformation, wear or other defects. If links require renewal the chain is to be suitably heat treated and re-tested. Replacement links are to be of equivalent material and strength to original (iii) Confirm that material is recorded on test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel
(10) Rope drums	<ul style="list-style-type: none"> (i) At least two turns of wire rope are to remain on the drum in all operating positions, including in the case of luffing ropes, when the jib is 'crutched' (ii) Check that the anchorages of all wire ropes are effective (iii) Check drum for cracks and for defects liable to damage the rope (iv) Check the effective working of any fleeting device fitted
(11) Re-test	<ul style="list-style-type: none"> (i) Loose gear is to be proof tested if repairs have been carried out which affect the strength or if certificates are not available (ii) Re-testing of the crane is necessary at 4 or 5 yearly intervals as appropriate and after repairs have been carried out affecting the strength or otherwise as required by the Surveyors. The test is to demonstrate satisfactory operation, efficiency of overload and weightload indicators, effectiveness of limit switches, etc. (iii) It is essential that the crane is operated at each survey to check hoist, slewing, luffing and travel motions, and the operation of limit switches for over-hoisting, over-lowering, luffing, slewing and travel (iv) Lifting appliances used for raising, lowering or transferring manned submersibles are to be re-tested annually and also following any structural repairs, alteration or re-erection of the appliance (v) Lifting appliances used for raising, lowering or transferring manned bells or submarines are to be re-tested annually and also following any structural repairs, alteration or re-erection of the appliance

Table 9.3.5 Annual Survey of cargo lifts and ramps (see continuation)

Item	Survey
(1) Arrangements	Check that the reeving of wire ropes, chains or the arrangement of hydraulic cylinders is as shown on the reeving diagram or appropriate plans. Check marking on ramps of lifts with respect to ships loading booklet and 'Register of Ship's Cargo Gear and Lifting Appliances'
(2) Sheaves, sprockets, guide rollers, axle pins and bearings, etc.	<ul style="list-style-type: none"> (i) Determine that sheaves, sprockets and guide rollers, etc., are free from cracks or scores and that they are free to rotate (ii) Survey rope grooves for scoring and sprockets for signs of abnormal wear, hooking, etc. (iii) Check that lubrication arrangements are in working order (iv) Check axle pins and bearings with regard to deformation and excessive wear
(3) Wire ropes	<ul style="list-style-type: none"> (i) Survey condition of rope (ii) Check for broken, worn or corroded wires. In general, the rope is to be replaced if the number of broken, worn or corroded wires exceeds the limit given in Table 9.3.2 (iii) Survey terminal fittings, splices, etc., with particular attention to broken wires at ferrule connections. Any serving on splices is to be renewed for this examination

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Table 9.3.5 Annual Survey of cargo lifts and ramps (conclusion)

Item	Survey
(4) Chains	<ul style="list-style-type: none"> (i) Survey the chain, which is to be sufficiently free from grease and scale, etc., to enable a satisfactory examination to be made (ii) Check for deformation, wear or other defects. If links require renewal, the chain is to be suitably heat-treated and re-tested. Replaced links are to be of equivalent material and strength to the original (iii) Confirm that material is recorded on the test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel
(5) Hydraulic cylinders, winches, etc., and attachments	<ul style="list-style-type: none"> (i) Survey for leaks and check condition of hydraulic pipes (ii) Check pistons, pivot pins and bearings, etc., for excessive wear and deformation (iii) Determine that sheaves are free from cracks or scores and are free to rotate (iv) Check that mounting brackets are free from deformation, cracks or damage
(6) Main pivots, slewing bearings, etc.	<ul style="list-style-type: none"> (i) Check that main pivots and bearings are free from excessive play (ii) Check that bearing surfaces are free from scoring, pitting, etc. (iii) Check that pivot pins do not have excessive wear or deformation (iv) Check that lubrication arrangements are in working order
(7) Structure and general	<ul style="list-style-type: none"> (i) Check bolts for tightness. Where bolts have been replaced, they are to be of the same type and quality as previously fitted (ii) Check welds for cracks (iii) Survey structure for corrosion, removing paint and carrying out hammer tests as necessary. If considered necessary the thickness of structural items is to be checked by drilling or other suitable methods (iv) Check load bearing plating and main structural members for local indentation or unfairness
(8) Shackles, links, etc.	<ul style="list-style-type: none"> (i) Check for cracks, deformation, wear, wastage or other defects. Items are to be free from paint, grease, scale, etc. (ii) Confirm that material is recorded on test certificate. The certificate is to distinguish between mild steel, higher tensile steel and alloy steel (iii) If deformation of the shackle is found and re-setting is carried out, the shackle is to be suitably heat treated, re-tested and certified (iv) If the shackle pin is renewed, the whole shackle is to be re-tested and certified
(9) Rope drums	<ul style="list-style-type: none"> (i) At least two turns of wire rope are to remain on the drum in all operating positions (ii) Check that the anchorages of wire ropes are effective (iii) Check drums for cracks and for defects liable to damage the rope (iv) Check the effective working of any fleeting device fitted
(10) Operating locks, stowage locks, safety guards, etc.	<ul style="list-style-type: none"> (i) Check that operating locks, safety guards and stowage locks operate effectively (ii) Check locking pins on latches, etc., and their respective location bearing parts for abnormal wear or deformation (iii) Ensure that hydraulic actuating cylinders, etc., are free from leaks, wear and abnormal deformation (iv) Ensure that mounting brackets, etc., are effective and securely attached to the ship or lift structure
(11) Guides	<ul style="list-style-type: none"> (i) Check that the guides do not have excessive wear or deformation and that joints are secure (ii) Check that brackets attaching guides to ship structure are effective and in good order
(12) Seals	Where watertight seals are fitted, satisfy yourself that their general condition is satisfactory and check their effectiveness using a water spray test or other suitable method
(13) Re-test	<ul style="list-style-type: none"> (i) Re-testing of the lift or ramp is necessary at 4 or 5 yearly intervals as appropriate and when repairs have been carried out affecting the strength or as required by the Surveyor (ii) It is essential that the lift or ramp is operated at each survey throughout the full operational range for each mode of operation and to check that the limit switches, interlocks, guards and safety devices operate satisfactorily

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Table 9.3.6 Annual Survey of passenger lifts

Item	Survey
(1) Arrangements	<ul style="list-style-type: none"> (i) Check that the reeving of wire ropes and chains, and the arrangement of hydraulic cylinders is as shown on the appropriate plans (ii) Check that the plate indicating the allowable load mounted inside the lift is in agreement with the appropriate plan and as indicated in the 'Register of Ship's Cargo Gear and Lifting Appliances'
(2) Sheaves, sprockets, guide rollers, axle pins and bearings, etc.	<ul style="list-style-type: none"> (i) Determine that sheaves, sprockets and guide rollers, etc., are free from cracks or scores and that they are free to rotate (ii) Survey rope grooves for scoring and sprockets for signs of abnormal wear, hooking, etc. (iii) Check that lubrication arrangements are in working order (iv) Check axle pins and bearings with regard to deformation and excessive wear
(3) Wire ropes	<ul style="list-style-type: none"> (i) Survey condition of ropes (ii) Check for broken, worn or corroded wires. In general, the rope is to be replaced if the number of broken, worn or corroded wires exceeds the limit given in Table 9.3.2 (iii) Survey terminal fittings, splices, etc., with particular attention to broken wires at ferrule connections. Any serving on splices is to be renewed for this examination
(4) Chains	<ul style="list-style-type: none"> (i) Survey the chain, which is to be sufficiently free from grease and scale, etc., to enable a satisfactory examination to be made (ii) Check for deformation, wear or other defects. If links require renewal, the chain is to be suitably heat-treated and re-tested. Replaced links are to be of equivalent material and strength to the original (iii) Confirm that material is recorded on the test certificate. The certificate should distinguish between mild steel, higher tensile steel and alloy steel
(5) Hydraulic cylinders, winches, etc., and attachments	<ul style="list-style-type: none"> (i) Survey for leaks and check condition of hydraulic pipes (ii) Check pistons, pivot pins and bearings, etc., for excessive wear and deformation (iii) Determine that sheaves are free from cracks or scores and are free to rotate (iv) Check that mounting brackets are free from deformation cracks or damage
(6) Landing and car doors	<ul style="list-style-type: none"> (i) Check that the landing and car doors operate satisfactorily (ii) Check that interlocks on the doors operate effectively (iii) Survey the door and check that its fire resisting capacity is unimpaired
(7) Car and counterweight	<ul style="list-style-type: none"> (i) Examine the car and counterweight for damage which could affect their operating efficiency or carrying capacity (ii) Check that brackets for sheaves, guide rollers, wire terminals, etc., are secure and in good order (iii) Survey the car and check that its fire resisting capacity is unimpaired
(8) Lift trunk and well	<ul style="list-style-type: none"> (i) Check that the lift trunk and well are free from debris or damage which could impair the satisfactory operation of the lift (ii) Check that trunk has not been damaged, is suitably ventilated and is totally enclosed such as to prevent passage of smoke and flame from one deck to another
(9) Guides and buffers	<ul style="list-style-type: none"> (i) Check that the car and counterweight guides are not worn or distorted and that the joint plates are secure (ii) Check that brackets attaching guides to trunk are in good order (iii) Check that buffers are in good order and supports are sound
(10) Over-running devices and brakes	Check that over-running devices and brakes are operating satisfactorily and are in good order
(11) Safety gear	Check that safety gear for preventing the car from falling is secure and in good order
(12) Safety equipment	<ul style="list-style-type: none"> (i) Check that escape hatches, ladders, etc., are free from obstruction and in good order (ii) Check that the emergency telephone and warning system operate satisfactorily (iii) Check that all warning notices, etc., are legible and secure
(13) Re-test	<ul style="list-style-type: none"> (i) Re-testing is necessary at 4 or 5 yearly intervals as appropriate and when repairs have been carried out affecting the strength or as required by the Surveyor (ii) It is essential that the lift is operated at each survey to check that limit switches, interlocks and safety devices operate satisfactorily

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3.5 Deferment of surveys

3.5.1 Where requested by the Owner, LR is willing to carry out a General Examination of the lifting appliances with a view to deferment of survey provided:

- (a) Agreement to the proposed deferment is granted by the National Authority of the flag state of the ship. Certain National Authorities have authorized LR to grant deferments without seeking specific agreement on each occasion.
- (b) The certification is valid, up to date and issued by a competent authority.

3.5.2 The General Examination is to take the form of a visual inspection of the lifting appliances but the Surveyor may at his discretion require components to be dismantled for more thorough examination where considered necessary.

3.5.3 Where such deferment is granted, it is to be for not more than:

(a) Derricks:		
Quadrennial Survey	6 months from due date	
(b) Cranes and derrick cranes	3 months from due date	
(c) Cranes on fixed or mobile offshore installations or for diving systems:		
6-monthly survey	no deferment	
(d) Lifts and ramps:		
Annual Survey (unpowered lifts)	no deferment	
6-monthly survey	no deferment	

3.5.4 Such deferments will not extend the due dates of subsequent Periodical Surveys.

3.5.5 Any aspects of the installation which are not considered suitable to continue in use during the period of deferment are to be noted in the endorsement to the 'Register of Ship's Cargo Gear and Lifting Appliances'.

3.5.6 Following inspection of the lifting appliances and the 'Register of Ship's Cargo Gear and Lifting Appliances', a factual report is to be issued and this is to include a statement, where applicable, of the authority for granting the deferment.

3.6 Damage surveys

3.6.1 The stated cause of the damage is to be reported together with details of the proposed repair and the extent of repair and re-testing actually carried out at the time. Where it is not possible to carry out, or to complete, the repair at the time a suitable entry is to be made in the 'Register of Ship's Cargo Gear and Lifting Appliances' that the equipment is not to be used until satisfactory repairs and tests are completed.

3.6.2 Replacement items of loose gear are to be accompanied by a manufacturer's certificate or be tested, marked and certified by the Surveyor.

3.6.3 Care is to be exercised to ensure that the correct materials are used in the repairs.

3.6.4 The practice of allowing a damaged derrick or crane to continue in use at reduced capacity is not recommended. This is because of the resulting inherent weakness of the structure and, in the case of a crane jib or derrick boom, the difficulty of assessing the effect of any indentation or unfairness upon the load carrying capacity.

3.6.5 The equipment is to be re-tested in accordance with 1.9 after the repair has been completed and the 'Register of Ship's Cargo Gear and Lifting Appliances' has been endorsed.

3.7 Classification surveys

3.7.1 Where the lifting appliances are to be assigned a class in the *Register Book*, the Initial Surveys are to be carried out in accordance with 3.2 or 3.3 as appropriate. When the required reports on completion of the survey have been received and approved by the Committee, certificates of classification of the lifting appliances will be issued.

3.7.2 It is the responsibility of the Owner to ensure that all surveys necessary for the maintenance of class are carried out at the proper time and in accordance with the instructions of the Committee. The Society will give timely notice to an Owner about forthcoming surveys by means of a letter or quarterly computer print-out. The omission of this notice, however, does not absolve the Owner from his responsibility to comply with LR's survey requirements for the maintenance of class.

3.7.3 Periodical Surveys for the maintenance of class are to be carried out by LR's Surveyors in accordance with 3.4. Certificates of class maintenance in respect of completed Periodical Surveys will be issued to Owners on application.

3.7.4 It should be noted that the intervals between Periodical Surveys of lifting appliances are determined by Statutory Regulations and deferments cannot exceed those permitted by 3.5.

Section	
1	General
2	Certification procedure
3	Classification procedure

1.3 Classification certificates

1.3.1 Where the lifting appliance is to be classed, certificates of classification and subsequent certificates of class maintenance will be issued on compliance with the appropriate requirements. The certificates are listed in Tables 10.1.1 and 10.1.2.

■ **Section 1**
General

1.1 Procedure

1.1.1 The procedure and requirements for the issue of certification by Lloyd's Register (hereinafter referred to as LR) are specified in Ch 1,2.

1.1.2 Certification of all lifting appliances, with the exception of mechanical lift docks and lifting gear for diving systems, is to be on the basis of the appropriate certificates detailed in this Chapter.

1.1.3 Mechanical lift docks whether classed or certified are to be covered by reports and certificates as laid down in Chapter 4.

1.1.4 Launch and recovery systems for diving operations are to be classed or certified as required by LR's *Rules and Regulations for the Construction and Classification of Submersibles and Diving Systems* (hereinafter referred to as the Rules for Submersibles).

1.1.5 Where the lifting appliance is also to be classed, the requirements of Ch 1,3 are to be complied with. The appropriate classification certificates are detailed in this Chapter.

1.2 Certificates for certification

1.2.1 Certificates are to be prepared, and are to be kept available, showing that:

- (a) Satisfactory tests have been carried out on the individual items of loose gear and on each lifting appliance as rigged for its intended mode of operation.
- (b) The required Periodical Surveys of each lifting appliance have been carried out.

1.2.2 The certificates issued by LR are based upon the I.L.O. series and are listed in Table 10.1.1 together with relevant comments.

1.2.3 LR's certification is internationally accepted but in certain cases a National Authority may require its own certification to be used. Where authorized, LR can also arrange the issue of these certificates, which may be in addition to LR's certification if so desired by the Owner.

Documentation**Chapter 10**

Section 1

Table 10.1.1 Certificates for certification

Certificate	LR Form Number	Title	Comments
LA.1	1365	Register of Ship's Lifting Appliances and Cargo Handling Gear	This is the document in which all the lifting appliances which have been certified are listed and subsequently periodical, damage and other surveys are recorded. Certificates of examination and test of the lifting appliances and certificates for ropes and individual items of loose gear are to be attached to this document
LA.2	1380	Certificate of Test and Thorough Examination of Lifting Appliances	This certificate is to be used for all lifting appliances. This certificate is to be re-issued following subsequent re-tests.
LA.2U	1381	Certificate of Test and Thorough Examination of Derricks used in Union Purchase	Must be accompanied by LA.2
LA.3	1382	Certificate of Test and Thorough Examination of Loose Gear before being taken into use, and of such gear after it has been altered or required	Contents may be transferred from manufacturer's test certificate, the number of which is to be stated on the LA.3. Reference to 'altered or repaired' loose gear means alterations or repairs which affect the strength of the item A pulley block may be considered to include any special shackles or other fittings designed to fit and work exclusively with the block. These fittings may be tested with the block and should have the same certificate identification mark This certificate is also to be used for spreaders, lifting beams and similar items of equipment
LA.4	1383	Certificate of Test and Thorough Examination of Wire Rope, before being taken into use	This certificate may be re-issued following subsequent periodical re-testing independent of the lifting appliance (i.e. workshop re-testing), if such re-testing is specifically required by a National Authority
LA.5	1384	Certificate of Test and Thorough Examination of Fibre Rope, before being taken into use	Each length of wire rope is to be supplied with a certificate. The certificate may be made up from the master certificate supplied by the rope manufacturer with each coil of rope. In the absence of a master certificate, or if this cannot be related to the particular lengths of rope, then each length is to be tested and a LA.4 issued on the basis of these tests
—	—	Certificate of Classification of Lifting Appliances and Associated Gear	There is no equivalent I.L.O. form but a LA.5 is to be issued in all cases where fibre or man-made ropes are used The comments applicable to LA.4 also apply
—	—	—	To be issued for all lifting appliances to which a class notation has been assigned

Table 10.1.2 Additional certificates for certification

Certificate	LR Form Number	Title	Comments
CG.11	1400	Certificate of Fitness of Cargo Gear	Issued only to Greek flag ships in accordance with Greek Presidential Decree, PD 131/81. To be issued after satisfactory completion of LAQC. A copy to be forwarded to the London office, LAMH (see 2.5)
CG.12	1707	Certificate for Personnel Lifts	Issued only to NIS flag ships in accordance with NMD – Class Instructions – NIS. To be issued upon completion of satisfactory plan approval, survey and test (exceptions detailed in 2.5). A copy to be forwarded to the London office, LAMH
Report 11 (NIS)	2586	Survey and Control of Personnel Lifts	Issued only to NIS flag ships in accordance with NMD – Class Instructions – NIS. To be issued upon completion of each survey of the lift. A copy to be forwarded to the London office, LAMH (see 2.5)

■ **Section 2** **Certification procedure**

2.1 Initial Surveys

2.1.1 Following satisfactory completion of all the conditions required for the issue of certification by LR, the *Register of Ship's Lifting Appliances and Cargo Handling Gear* – LA.1, or the equivalent National Authority form, is to be issued and the appropriate loose gear, rope and appliance test certificates attached.

2.1.2 Where LR's Surveyors have not witnessed the testing of loose gear, a manufacturer's certificate of test is to be supplied and the information entered on the appropriate certificates issued by the Surveyor.

2.1.3 Where part of a survey is carried out at a manufacturer's works away from the shipbuilding port, a report is to be issued covering the survey together with any loose gear certificates. The appropriate test certificate is only to be issued upon satisfactory completion of on board tests and inspection.

2.1.4 The *Register of Ship's Lifting Appliances and Cargo Handling Gear* is to be endorsed in Parts I and II and, if specifically requested by the Owner, a factual report may also be issued.

2.1.5 The survey is to be reported to the London office.

2.2 Periodical Surveys

2.2.1 Provided the existing register is valid and up to date and complete with all certificates, it is to be endorsed upon satisfactory completion of the survey. It is normally sufficient to endorse the register and attach any new certificates, but a factual report may also be issued if requested by the Owner.

2.2.2 In view of the attitude that some National Authorities adopt with respect to the competence and independence of the person carrying out the survey, such as ship's officer, it is recommended that for registers issued by LR only LR's Surveyors carry out the survey if delays and inconvenience to Owners are to be avoided.

2.2.3 If re-testing is carried out, as in the case of an LAQC (every fifth or fourth year depending on whether or not the ship has adopted the five year cycle in accordance with ILO Convention 152), a new Form LA.2 is to be issued. Where the register is not on LR's forms, the appropriate National Authority certificate is to be issued.

2.2.4 The appropriate section of the register is to be endorsed, Part I for the appliance and Part II for the loose gear.

2.2.5 Any replacement items of loose gear or ropes must be accompanied by a manufacturer's test certificate, see also 2.1.2.

2.2.6 The survey is to be reported to the London office.

2.3 Damage surveys

2.3.1 As for all surveys, before undertaking a damage survey it should be verified that the existing register is valid and up-to-date. It will not be possible for surveys to be undertaken by LR where the register is not available or not valid and up-to-date except in exceptional circumstances.

2.3.2 The register is to be endorsed indicating the extent of the survey even if it was not possible to complete the repairs.

2.3.3 A factual report is to be issued clearly stating:

- (a) Who requested the attendance.
- (b) The stated cause of the damage.
- (c) The extent and nature of the damage found.
- (d) The extent and nature of repairs carried out and whether the repairs were complete.
- (e) The test load applied.
- (f) Whether any part of the gear is not to be used pending further action, replacement, etc.

2.3.4 The survey is to be reported to the London office.

2.4 Deferment of survey

2.4.1 Where a deferment of survey has been granted, see Ch 9,3.5, the register is to be endorsed and a factual report is to be issued. The survey is to be reported to the London office.

2.5 Other surveys

2.5.1 Surveys not previously specified will be specially considered or will be covered by separate instructions since they will normally involve the specific requirements of a National Authority.

■ **Section 3** **Classification procedure**

3.1 General

3.1.1 When the required reports on completion of the Special Survey during construction of the lifting appliances which have been submitted for classification have been received from the Surveyors and approved by the Committee, certificates of classification will be issued to the Builders or Owners.

3.1.2 Certificates of class maintenance in respect of completed Periodical Surveys will also be issued to Owners on application.

3.1.3 LR's Surveyors are permitted to issue provisional (interim) certificates provided the lifting appliance is, in their opinion, in accordance with the applicable requirements. Such certificates will embody the Surveyor's recommendations for continuation of class but in all cases are subject to confirmation by the Committee.

3.1.4 In all cases, the necessary certificates for Certification will also be issued.

3.1.5 The survey is to be reported to the London office in addition to appearing on the appropriate classification report forms.

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